JUL 5 1911

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

Entered as second-class matter May 7, 1906 at the Post Office at San Francisco Cal., under the act of Congress March 3, 1879

VOL. XXVII NO. 1 | SAN FRANCISCO, JULY 1, 1911 | PER COPY, 25 CENTS

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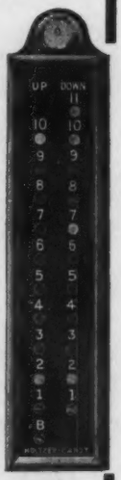

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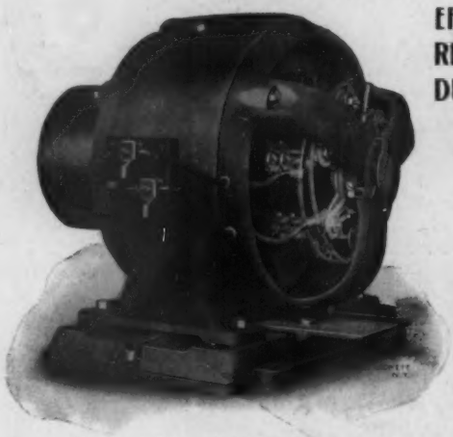

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JOURNAL OF ELECTRICITY
POWER AND GAS
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VOLUME XXVII. SAN FRANCISCO, JULY 1, 1911 NUMBER 1

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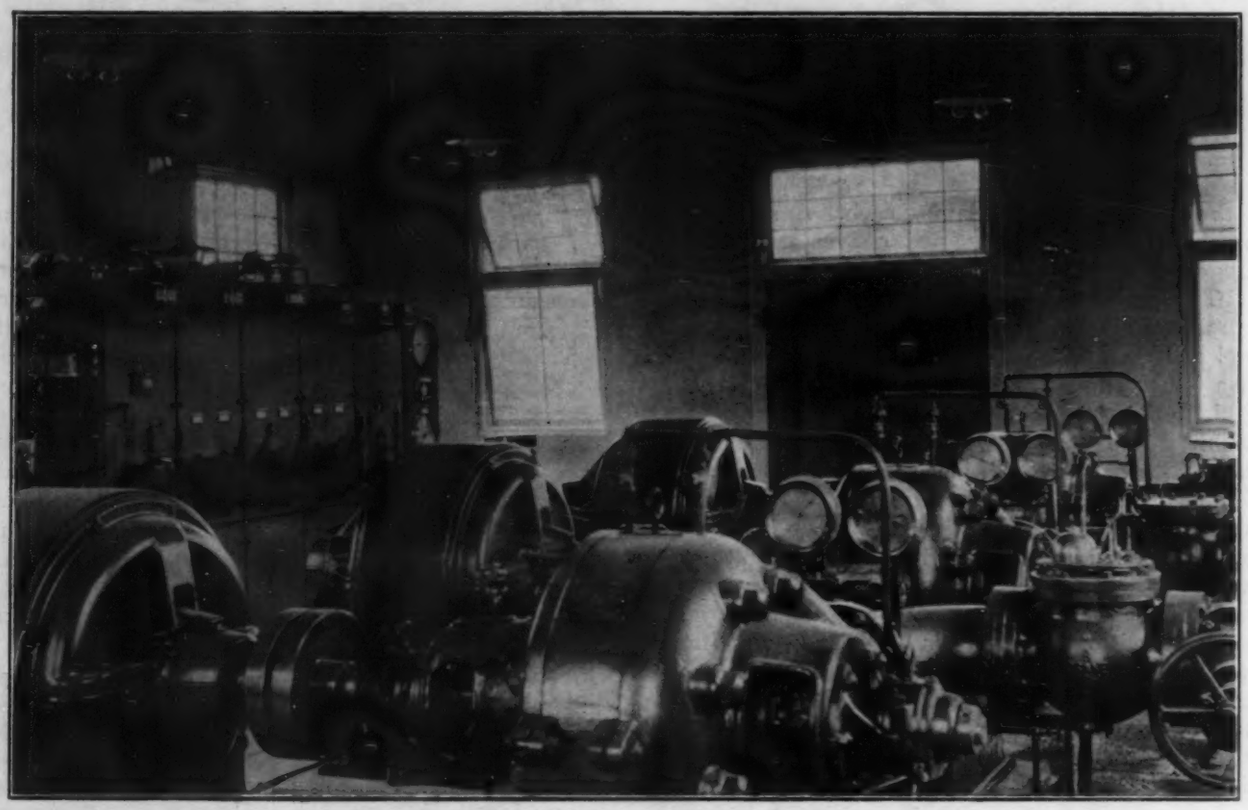
A MOTOR DRIVEN CITY PUMPING PLANT

BY GASKELL S. JACOBS.

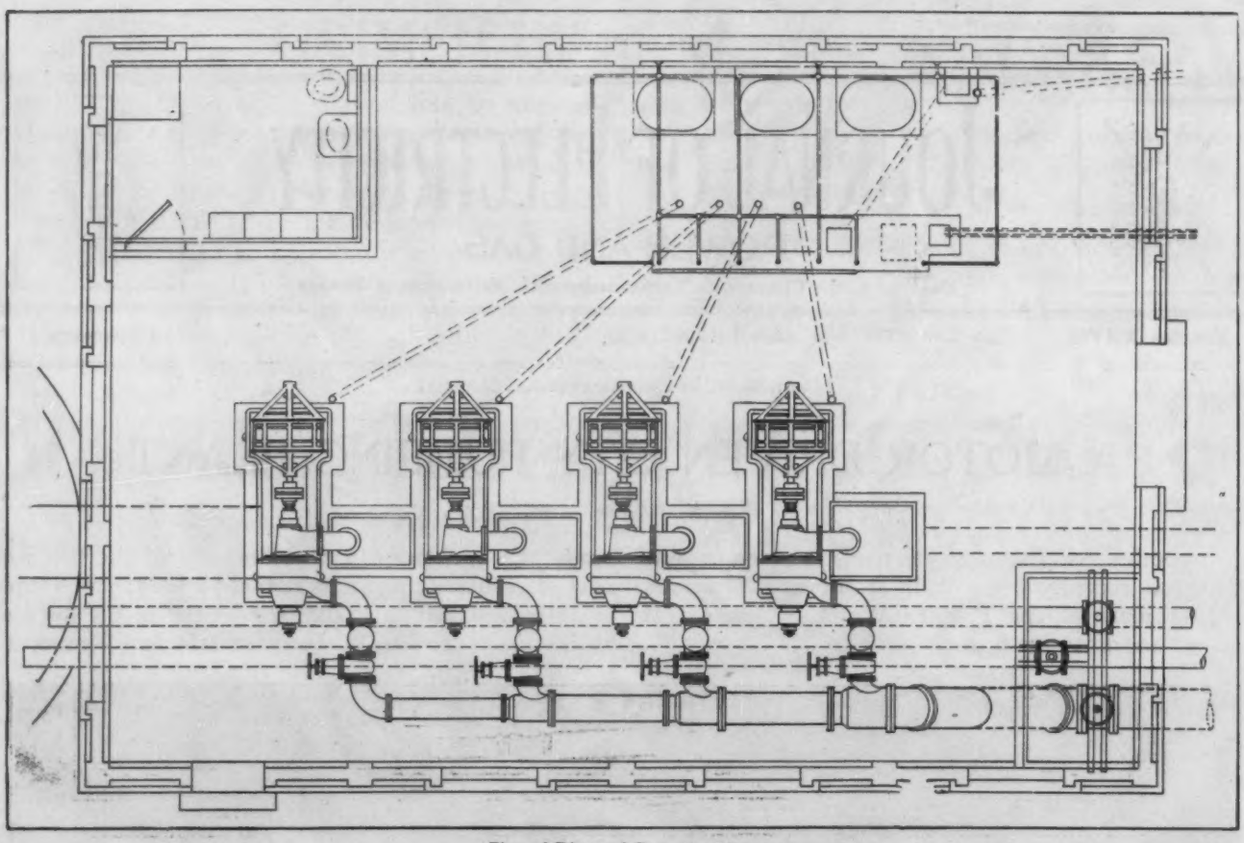
A notable installation of electrically driven turbine pumps has recently been made at the new Diamond pumping plant of the Peoples Water Company at Fortieth and Diamond streets, Oakland.



Interior of Diamond Pumping Plant of Peoples Water Company

In 1907, to meet the demands of water supply in the rapidly growing districts of North Oakland and Berkeley and to supplement the Berkeley supplies, a steam driven reciprocating pumping plant of about six million gallons daily capacity was installed in this locality. This temporary plant showing considerable deterioration and the requirement of the district being more definitely established, it was decided to abandon and dismantle the steam plant, and install a permanent booster plant in its place. Satisfactory arrangements for a dependable supply of electric power having been made at a low price, a consideration of the low first cost of an electric plant, its reduced attendance charges, maintenance and depreciation resulted in the decision to install an electrically operated station. The subsequent performance and reduced operating costs of the plant, which has been running since June 1, 1911, have confirmed the wisdom of this decision.

The plant is located on the east side of Diamond street, south of Fortieth, opposite the old steam station, at an elevation of about 83 ft. The plant is housed in an ample, well-lighted building 30x44 ft. in plan with walls 18 ft. high of reinforced concrete, with a steel roof structure and concrete slab roof and floors. The walls are finished inside and out with cement plaster. At night the station is lighted by six clusters



Plan of Diamond Pumping Plant

of three 60-watt Mazda lamps each. A small room containing lockers, stores, and conveniences is partitioned off at a rear corner of the building.

The present installation provides for a pumping capacity of six million gallons daily under a variable head of from 220 to 280 ft., in three units, with space for a fourth similar unit, making an ultimate capacity of eight million gallons per day, thus insuring both flexibility and reserve, with provision for future increase in consumption. The supply is taken from a 16-in. main on Fortieth street into which are connected the ends of the network of the distributing pipes of the City of Oakland, and is carried into the station through two 10-in. intake pipes with regulating gates operated inside the building. The discharge main, 16 in. in diameter and over 13,000 ft. in length, runs out Broadway, College avenue and Webster street to Claremont reservoir, situated at an elevation of 295 ft., supplying the intermediate sections of Oakland and Berkeley through branch mains and, in addition, a part of the Linda Vista district. At night the pressure is high, the water flowing directly to the reservoir; during the day, however, the pressure at the pumps is reduced, due to the use of water along the line, the supply being then furnished from both ends of the main. The pumps respond easily to these variations in pressure and delivery and are so designed as to keep approximately constant full load on the motors without a reduction in efficiency.

The water flows into a covered sump 20 ft. in diameter and 7 ft. deep at the rear of the building with an electrically operated high and low water alarm, thence through a tunnel under the building, in which are the pits for the suction pipes, which drop through openings in the floor above. A 12-in. tile drain leading to a nearby storm sewer carries the overflow from the tunnel. There are three 8-in., 2-stage, horizontal turbine pumps running at a speed of 1780 r.p.m., direct connected by flexible leather link couplings to 440-volt, 3-phase induction motors rated 150 h.p. each. The pumps are fitted with ring oiling bearings, water sealed stuffing boxes, enclosed non-overloading runners, renewable diffusion vanes, and adjustable thrust balance. They are primed by direct pressure from the mains, the suctions being provided with foot valves. The discharge pressure varies from 95 to 120 lb. per sq. in., and the suction lift averages 9 ft. with a delivery of 1800 to 1400 gallons per minute, over which range a pump efficiency of better than 70 per cent is maintained.

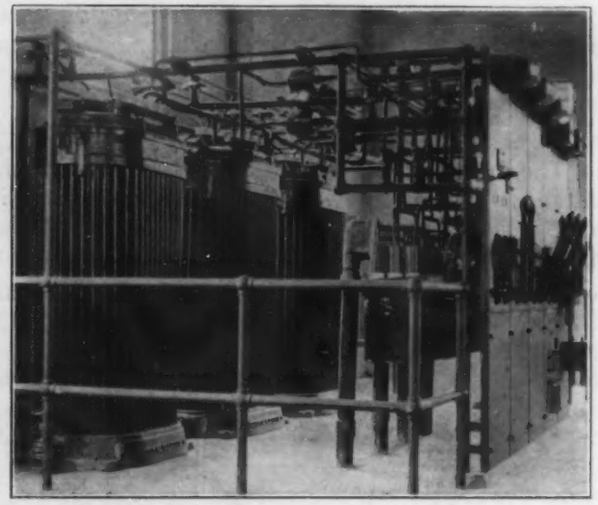
The induction motors have squirrel cage windings, enclosed frames, with ventilating fan blades attached to rotor. Their normal full load power factor is 96 per cent, and under the steady full load show a high efficiency. They are mounted on the extended base plates of the pumps.

The operation of the station is noticeable for its smoothness, uniformity, and absence of all shock and disturbance in the discharge main. Each pump discharge is fitted with check and gate valves and long sweep fittings connect them to the main 16-in. discharge header. These gates are not manipulated while running, the pumps automatically responding to all changes of pressure and delivery. The intakes and discharge mains are regulated from a group of valves in a pit at the front of the building and operated from wheel stands above. In full view of the operator at

the wheels, are placed the indicating gauges, mounted on a slate panel.

The power demand of the station is uniform and continuous throughout the day and night, and is supplied from a 3-phase, 4-wire, 4000-volt line from the Temescal substation of the Oakland Gas, Light & Heat Company. It is connected through an underground service and an 11,000-volt oil station switch to a bank of three 125-kw. transformers, placed within the building and stepping down to 440 volts for the motors. These transformers are supplied with 220-volt taps for starting the motors, thus obviating the use of starting compensators.

The switchboard consists of five slate panels, one for the station switch and motors, four remaining for triple pole, double throw oil switches. These switches are provided with overload and no voltage releases and are interlocked, being used to throw over the motors from the starting to running voltage. All the bus bars, wiring, current and potential transformers for meters, high tension feeders and switchboard panels are carried on a pipe frame, which also serves as a railing enclosure for the electrical apparatus. All conduits for wires, supplying light and power are concealed in the walls and floor of the building. All small water pipes for station use and pump priming are buried in the concrete floor, and the drains from the pumps discharge



Switchboard and Transformers.

into a vitrified conduit under the floor connecting with the overflow. The motor leads are 3-conductor lead-covered cables running in conduits under the floor from the switches back of the switchboard to the motor terminals, both ends being provided with porcelain outlet bushings.

To measure, indicate and register the delivery from the pumps, a 16x8 in. Venturi meter is set in the main discharge line just without the building, and the pressure pipes run to an automatic indicator and recorder at the end of the main switchboard. Each pump is equipped with pressure and vacuum gauges. The station output is measured by recording pressure gauges, and the recording meter, the switchboard instruments account for all the power consumed, so that the performance of the station at all times is closely known.

The pumps were furnished by the Byron Jackson Iron Works. The switches, switchboard, motors, transformers, and other electrical equipment by the General Electric Company, and the complete design and plans of the station, the pumping and electrical equipment, construction of the building, and installation of the machinery was in charge of the writer as assistant engineer of the Peoples Water Company.

INDUSTRIAL LIGHTING.

The National Association of Manufacturers' committee on ventilation, heat and light find that the effect of varying character of artificial light on the quantity and quality of product produced may be and very often is very great and, consequently, affects the cost of production to a very considerable extent; and feels that it is a matter of ordinary observation to those at all expert in the question of artificial lighting that factory lighting, generally speaking, is very far from what it ought to be. The following statement is a brief summary of the principal defects which are ordinarily to be found.

In very many cases there is insufficient illumination. This condition, however, is rapidly improving as the result of the advent of lamps of various kinds of much higher efficiency than anything that has been available in the past. It is a fact, however, that in a great many cases where the absolute amount of illumination is sufficient, the light is nevertheless exceedingly unsatisfactory for various reasons. If the light falls on the work from the wrong direction, not only is there great liability that awkward shadows of the machinery or of the operative's body will interfere with the work, but in addition if light is reflected from polished portions of the machinery or from the work itself directly into the eyes of the operative, the results will be anything but satisfactory. Failure of light to come in the right direction is often distressing to the eyesight and also, in addition, since it may cause the operative to work in an unnatural position, it may result in unnecessary bodily fatigue as well. Such unfortunate results are often obtained if an attempt is made to light a workroom with too few sources of light. Under these conditions, although some operatives may receive a satisfactory light, others are extremely likely to get the light in the wrong direction, with the unsatisfactory results above enumerated.

Another very common defect in factory lighting is the exposure of the eyes of the workers to the direct beams of very brilliant lamps. The use of bare incandescent lamps is almost invariably not only insufficient, but also dangerous. Generally, however, there is no difficulty in avoiding this trouble if proper care is taken.

Still another defect often seen is either too great or too little contrast in the illumination of rooms. The former of these is by far the most common and as an example might be given work on sewing machines, where individual lamps with opaque reflectors are supplied which brilliantly illuminate the machines, but leave the rest of the room in comparative darkness.

METHODS OF CALCULATING ILLUMINATION.[1]

BY L. S. TWOMEY.

In taking up the subject of illumination calculations, it is first necessary to obtain a clear conception of certain fundamental principles, definitions and units. Let us consider a symmetrical light source at the center of a sphere. The total flux of light, which is measured in lumens, flowing away from this source, we will designate as F. The flux per unit of solid angle is the intensity I and is the measure of the candle power of the source. From this it is seen that for a point source, candle power is independent of distance from the source, as the same flux is within the cone at all distances.

The luminous flux falling on the interior of the sphere produces the illumination E, which may be defined as the quantity of flux per unit area of the surface illuminated. Hence $E = \frac{F}{4\pi r^2}$. If our light source has an intensity of 1 candle in all directions, the amount of flux contained in each unit solid angle will be one lumen, and if the sphere be considered as having a radius of 1 foot, it follows that each square foot of its surface receives one lumen from the source. and by definition, the illumination produced is one foot candle. The total flux flowing away from the source is one spherical candle, and since there are 4π units of solid angle in the sphere, 1 spherical candle $= 4\pi$ lumens.

Since the area subtended by one unit of solid angle varies directly with the square of the radius, and for a given candle power the flux within the angle remains constant, it follows that the flux falling on one unit of area, together with the illumination, varies inversely with the square of the radius. This is known as the law of inverse squares.

In practical lighting units, the distribution of light is symmetrical only about one axis. It is therefore necessary that we have some method of ascertaining the total light flux and its distribution about the source. It is customary to obtain the polar distribution curve of light about the source, and then to calculate the total flux by one of several different methods.

The polar distribution curve is usually obtained by measuring the candle power at a number of angular positions in a plane containing the axis of symmetry. The unit is generally rotated about this axis while the readings are being taken, in order to equalize any possible lack of symmetry. Thus it will be seen that each reading is the candle power at the center of a zone of the sphere. (See Fig. 1). Several such distribution curves are shown in Fig. 15, 16 and 17.

It must be remembered that the total number of lumens emitted by the source is not in any way proportional to the area of the distribution curve. A light source of uniform candle power in all directions, radiates a greater flux in a zone near the horizontal than it does in an equiangular zone near the vertical. This is readily seen, because the area of the zone nearer the horizontal is greater than that of the zone nearer the vertical.

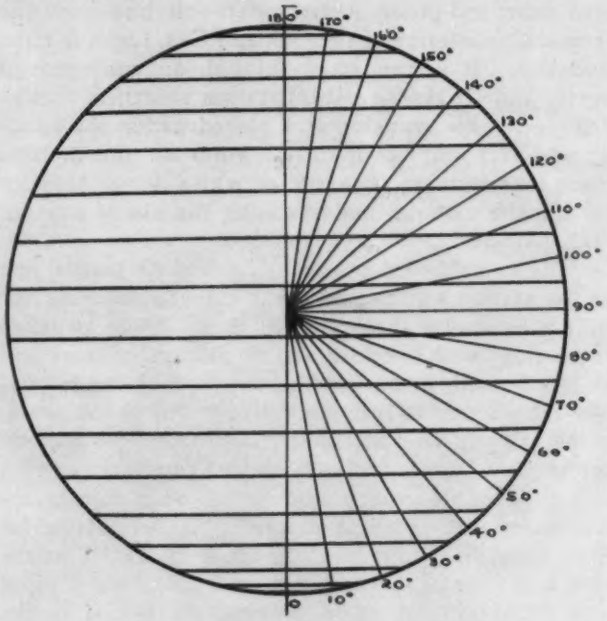


Fig. 1.

There are several methods of obtaining the total flux from the distribution curve, including the Rousseau diagram, the Kennelly diagram, and the Fluxolite diagram.

Rousseau Diagram.

The Rousseau diagram is the oldest of these methods, and is shown in Fig. 2. The distribution curve is plotted on ordinary polar co-ordinate paper at the left, while the Rousseau diagram is shown at the right.

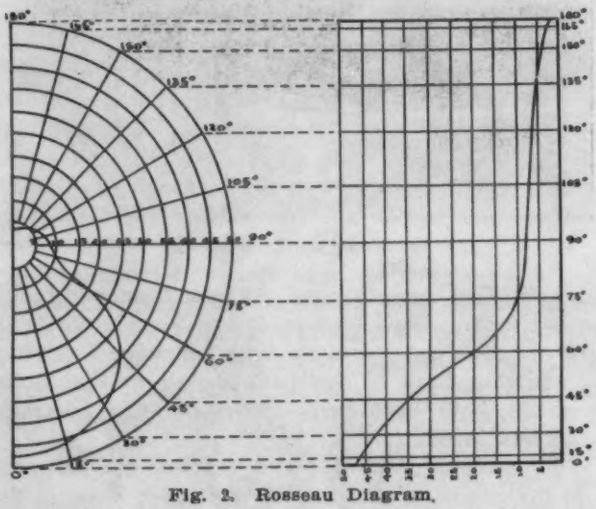


Fig. 2. Rosseau Diagram.

This sheet is laid out by projecting the various polar radii to form the horizontal lines, the vertical lines being to a uniform scale, and representing candle power. The candle power readings are plotted on this sheet at their respective angular positions, and the average ordinate of the curve is proportional to the total flux emitted by the source. Similarly the average ordinate of the curve for any zone is propor-

[1]Paper presented before San Francisco Section A. I. E. E., June 23, 1911.

tional to the flux emitted in that zone. In practice it is customary to measure the area of the curve with a planimeter, and then from this area and the scale to which the curve is plotted, to obtain the mean spherical candle power of the unit. Multiplying this value by 4π gives the result in lumens. If the Rousseau diagram be divided into twelve areas of equal height, the ordinates at the centers of these zones may be read, and their sum, divided by twelve will give the approximate average ordinate of the diagram without the use of a planimeter.

This forms the basis of the method of obtaining spherical intensity by direct average. (See Fig. 3).

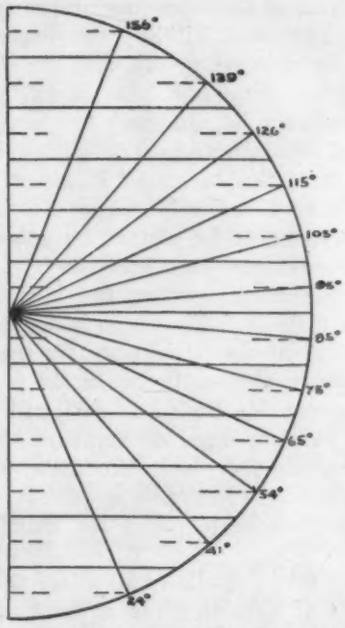


Fig. 3. Spherical Intensity by Direct Average.

The various radii are located by projecting the centers of the zones of equal height onto the circle. This diagram can be drawn on transparent celluloid and laid over a distribution curve, and the candle power value read at the intersection of each radius with the distribution curve. These readings will be the same as those obtained at the centers of the zones of equal height on the Rousseau diagram, and, on being averaged, will be numerically equal to the M. S. C. P. of the curve.

Based on the Rousseau diagram is a series of constants which may be used for obtaining an approximate value of the mean spherical candle power or mean

Angles at which C.P. is read,	M.S.C.P. Constants	M.H.S.C.P. Constants
0 - 10 - 170 - 180	.0038	.0076
10 - 20 - 160 - 170	.0113	.0226
20 - 30 - 150 - 160	.0184	.0368
30 - 40 - 140 - 150	.0250	.0500
40 - 50 - 130 - 140	.0308	.0616
50 - 60 - 120 - 130	.0357	.0714
60 - 70 - 110 - 120	.0395	.0790
70 - 80 - 100 - 110	.0421	.0842
80 - 90 - 90 - 100	.0434	.0868

Fig. 4. Multipliers for Obtaining M. S. C. P. and M. H. S. C. P. from Candle Power Reading.

hemispherical candle power. (See Fig. 4). The approximation lies only in the assumption that the curve is a straight line between readings. This assumption is made, however, in almost all practical work. To use these constants it is only necessary to add the four candle power readings at the various angles denoted in each line of the first column, multiplying the result by the constant given in the second column. After proceeding through the whole distribution curve in this manner, the sum of the products will be numerically equal to the mean spherical candle power of the curve.

Similarly, to obtain either the upper or lower mean hemispherical candle power, add the two candle power readings at the angles denoted in each line of the first column, using the upper or lower hemispherical readings as desired, and multiply the sum by the constant in the third column. The sum of these products will be numerically equal to the mean hemispherical candle power of the curve.

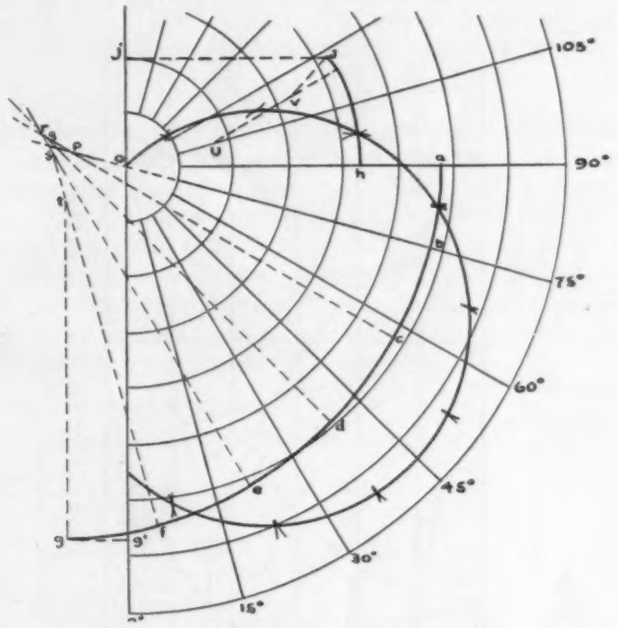


Fig. 5. Construction of Kennelly Diagram.

Kennelly Diagram.

The Kennelly diagram has the advantage of requiring only a protracter and pair of compasses for its construction. See Fig. 5. The construction is best shown by means of an example. On the distribution curve shown in the figure, with O as a center and the radius equal to the mid candle power of the 75-90 degree zone describe the arc ab, and the angle between Oa and Ob being 15 degrees. Then with a radius equal to the mid candle power of the 60-75 degree zone and center P on Ob, describe a second arc bc, the angle between Pb and Pc being 15 degrees. Then with a radius equal to the mid candle power of the 45-60 degrees, and a center q on Pc, describe the third arc, the angle between qc and qd being 15 degrees. This process is continued throughout the lower hemisphere, and if the diagram is accurately constructed, the line tg will be vertical. The procedure in the upper hemisphere is similar. Project the points J and g on the vertical, and one-half the distance J′ g′ to scale of the curve is numerically equal to the mean spherical candle power, the length OJ′ the mean upper hemispherical candle power and the length Og′ the mean lower hemispherical candle power.

Fluxolite Diagram.

The Fluxolite diagram is one of the most convenient methods of determining the flux in lumens in any zone or for the whole distribution curve. (See Fig. 6). It can be assumed without material error, that the flux in any zone ϕ = area of zone x mid candle power of zone. Since the areas of equiangular zones of a sphere are proportional to the sines of their bisecting angles, measured from the axis of the zones, $\phi = K I \sin a$.

Where ϕ = flux in zone, a = bisecting angle of zone, I = Mid candle power of zone, K = constant of proportionality.

But I sin a = horizontal projection of mid candle power.

Therefore, ϕ = K horizontal projection of mid candle power.

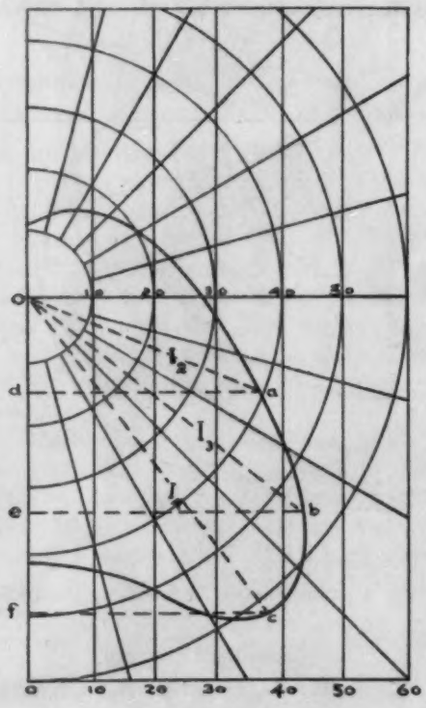


Fig. 6. Fluxolite Diagram.

To evaluate K. Area of zone, $A = \int_{a_1}^{a_2} 2\pi R \sin a \, da = 2\pi R [\cos a_2 - \cos a_1]$.

But since A = K sin a (bisecting angle)

$$\text{and } a = a_1 + \frac{a_2 - a_1}{2}$$

$$K \sin\left(a + \frac{a_2 - a_1}{2}\right) = 2\pi R [\cos a_2 - \cos a_1].$$

$$\text{Solving for K. } K = 2\pi R \frac{\cos a_1 - \cos a_2}{\sin\left(a_1 + \frac{a_2 - a_1}{2}\right)}$$

Substituting the various values for a_1 and a_2 in the above equation we obtain the values of K for zones of various angular widths.

To use these constants it is only necessary to measure, to scale of curve, the horizontal projections of the mid candle powers of the various zones, (See Fig. 7), and to multiply the sum of the projections by the proper value of K, depending on the angular width of the zones. The result will be given directly in lumens, which may be reduced to mean spherical candles by dividing by 4π. Similarly the mean hemispherical candle power may be obtained by dividing the flux in the desired hemisphere by 2π.

Width of zones	Constants
5 degrees	0.548
10 degrees	1.098
15 degrees	1.64
20 degrees	2.18
25 degrees	2.72
30 degrees	3.25
35 degrees	3.77
40 degrees	4.3
45 degrees	4.8

Fig. 7. Constants for Use With Horizontal Projections of Mid Candle Power of Equiangular Zones.

Referring to the values of K given in the table, we see that the value for 10 degree zones is 1.098. If the distribution curve be plotted on polar co-ordinate paper so dimensioned that 1.098 inches equals some multiple of the candle power, the horizontal projections may be measured directly in inches and on multiplying the sum of the projections by the multiple of the candle power, the result will be the flux in lumens.

Mr. Norman Macbeth has designed a polar flux scale which may be used to measure the horizontal projections, giving the result directly in lumens. It is necessary, however, to use this scale only with the particular polar co-ordinate paper for which it was designed.

We have taken up in detail all of the more common methods of obtaining the amount of light available for illuminating purposes from a given lighting unit and may now proceed to the various methods of calculating the illumination.

In order to compare the illumination produced by different installations, it is necessary to select some plane on which to measure the intensity. It is common practice to select a horizontal plane at a height determined by the purpose for which the illumination is to be used. This "working plane" as it is called, would be at the level of the desk tops in offices and at the level of counter tops in stores.

Point by Point Method.

One of the methods in use, is known as the point by point method, (See Fig. 8). This method takes no

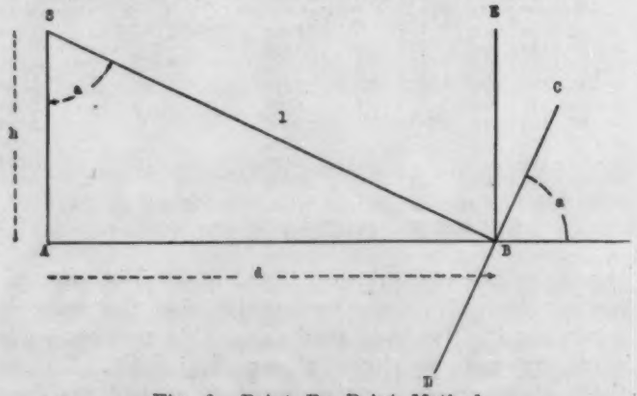


Fig. 8. Point By Point Method.

account of wall and ceiling reflection, but is nevertheless useful in determining the comparative uniformity of illumination from different sources and for determining heights and spacing of units.

Referring to the figure, let a = angle which light rays make with vertical; I_a = candle power in direction SB at angle a from vertical; E_a = Illumination on plane CD normal to Sb; E_h = Illumination on horizontal plane AB; d = distance from point beneath source to point where illumination value is desired; h = height of lamp above horizontal plane; I = distance from source to point B. Then the illumination at point B on plane cD,

$$E_a = \frac{I_a}{I^2}$$

Since $$I = \frac{h}{\cos a}$$

$$E_a = \frac{I_a \cos^2 a}{h^2}$$

Also $$E_h = E_a \cos a$$

Therefore $$E_h = \frac{I \cos^3 a}{h^2}$$

The value of I_a is found from the distribution curve of the source under discussion and the value of a may be computed from the values of h and d. To facilitate this work various tables (See Fig. 9), have been computed, giving the values of the angle a for various values of h and d, together with the illumination produced at the corresponding points on the horizontal plane by a one candle power source. To use this table it is only necessary to look up the value of a for the assumed values of h and d, together with illumination produced at the point by the one candle power source. Then from the distribution curve find the candle power at the angle a and multiply this by the illumination from the one candle power source.

The results calculated in the above manner may be represented graphically as shown in Fig. 10, where

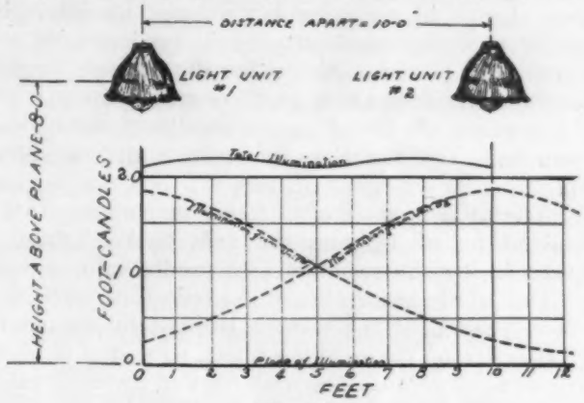


Fig. 10.

the abscissae represent various horizontal distances from the source, and the ordinates represent the corresponding illumination in foot candles.

The first step in designing a system of illumination for a given room is to select the intensity in foot candles. The intensity varies with different classes of service and considerable care should be used in making this assumption. Values are given in Fig. 11 for several common classes of service.

Class of Service	Light Intensity in Foot Candles
Auditoriums (General Illumination)	1 to 3
Theatres " "	1 to 3
Churches " "	2 to 3
Reading Rooms	1 to 3
Residences (General Illumination)	1 to 2
Desk Illumination	2 to 5
Postal Service	2 to 5
Bookkeeping	3 to 5
Stores, (General Illumination)	2 to 5
Stores, Clothing	4 to 7
Drafting	5 to 10
Engraving	5 to 10

Fig. 11.

Intensity of Illumination in Foot-Candles on Horizontal Planes at Points at Various Distances from a Light Source of 1 Candle-Power. Angle Between Light Ray and Line Perpendicular to Plane Illuminated

Horizontal Distance in Feet from Point Directly Under Light Source to Point Where Intensity of Illumination is Desired.

Height of Light Source in Feet Above Plane Illuminated

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
4	0° 0′ .06250	14° 2′ .05707	26°34′ 04472	36°52′ .03200	45° 0′ 02210	51°20′ .01524	56°19′ .01066	60°15′ .00764	63°26′ .00559	66° 2′ .00419	68°12′ 00320	70° 1′ .00249	71° 34′ 00198	72°54′ .00159	74° 3′ 00130	75° 4′ 00107	75°56′ .00090	76°46′ .00075	77°28′ .00064	78° 7′ .00055	78°42′ .00047
5	0° 0′ .04000	11°19′ .03771	21°48′ 03202	30°58′ .02522	38°40′ .01904	45° 0′ .01414	50°11′ .01050	54°28′ .00785	58° 0′ .00595	60°57′ .00458	63°26′ 00358	65°34′ .00283	67°23′ .00228	68°58′ .00185	70°21′ 00152	71°34′ 00126	72°39′ .00106	73°37′ .00090	74°29′ .00077	75°15′ .00066	75°56′ .00057
6	0° 0′ .02778	9° 28′ .02673	18°26′ .02372	26°34′ .01987	33°42′ .01600	39°48′ 01260	45° 0′ .00982	49°24′ .00766	53° 8′ .00600	56°19′ 00474	59° 3′ .00378	61°23′ .00305	63°26′ .00249	66°13′ .00205	66°48′ 00170	68°12′ .00142	69°27′ .00120	70°34′ .00102	71°34′ .00088	72°28′ .00076	73°18′ .00066
7	0° 0′ .02041	8° 8′ .01980	15°57′ .01814	23°12′ .01585	29°45′ .01336	35°32′ .01100	40°37′ .00893	45° 0′ .00722	48°49′ .00583	52° 7′ 00473	55° 1′ .00385	57°31′ .00316	59°45′ .00261	61°41′ .00218	63°26′ 00183	64°59′ .00154	66°23′ .00131	67°37′ .00113	68°45′ .00097	69°46′ .00084	70°43′ .00074
8	0° 0′ .01563	7° 8′ .01527	14° 2′ .01427	20°33′ .01283	26°34′ .01118	32° 0′ .00953	36°52′ .00800	41°10′ .00667	45° 0′ .00552	48°22′ .00458	51°20′ .00381	53°59′ .00318	56°19′ .00267	58°24′ .00225	60°15′ 00191	61°55′ .00163	63°26′ .00140	64°48′ .00121	66° 2′ .00105	67°10′ 00091	68°12′ .00080
9	0° 0′ .01235	6° 20′ .01212	12°32′ .01148	18°26′ .01054	23°55′ .00943	29° 3′ .00825	33°42′ .00711	37°52′ .00607	41°38′ .00515	45° 0′ .00437	48° 0′ .00370	50°42′ 00314	53° 8′ .00267	55°18′ .00228	57°15′ .00196	59° 3′ .00168	60°38′ .00146	62° 6′ .00126	63°26′ .00110	64°40′ .00097	65°46′ .00085
10	0° 0′ .01000	5° 43′ .00965	11°19′ .00943	16°42′ .00879	21°48′ 00801	26°34′ .00716	30°58′ .00631	35° 0′ .00550	38°40′ .00476	41°59′ .00411	45° 0′ .00354	47°43′ .00305	50°11′ .00263	52°26′ .00227	54°28′ .00196	56°19′ .00171	58° 0′ .00149	59°32′ .00130	60°57′ .00115	62°14′ .00101	63°26′ .00089
11	0° 0′ .00826	5° 12′ .00816	10°18′ .00787	15°15′ .00742	19°59′ .00686	24°27′ .00623	28°37′ 00559	32°28′ .00496	36° 2′ .00437	39°17′ .00383	42°16′ .00335	45° 0′ .00292	47°30′ .00255	49°46′ .00223	51°50′ .00195	53°45′ .00171	55°30′ .00150	57° 6′ .00132	58°34′ .00117	59°56′ .00104	61°12′ .00092
12	0° 0′ .00694	4° 46′ .00687	9° 28′ .00668	14° 2′ .00634	18°26′ .00593	22°37′ .00546	26°34′ .00497	30°15′ .00448	33°42′ .00400	36°52′ .00356	39°48′ .00315	42°31′ 00278	45° 0′ .00246	47°17′ .00217	49°24′ .00191	51°20′ .00169	53° 8′ .00150	54°49′ .00133	56°19′ .00119	57°43′ .00106	59° 3′ .00094
13	0° 0′ .00592	4° 24′ .00587	8° 45′ .00571	13° 0′ .00547	17° 6′ 00517	21° 2′ .00481	24°46′ .00447	28°18′ .00404	31°34′ .00366	34°42′ .00329	37°34′ .00295	40°14′ .00263	42°44′ .00235	45° 0′ .00209	47° 6′ .00187	49° 5′ 00166	50°54′ .00148	52°36′ .00133	54° 10′ .00119	55°38′ .00106	56°59′ .00096
14	0° 0′ .00510	4° 5′ .00506	8° 3′ .00495	12° 6′ 00477	15°57′ 00454	19°39′ .00426	23°12′ .00396	26°34′ .00365	29°45′ .00334	32°44′ .00304	35°32′ .00275	38° 9′ .00248	40°37′ .00223	42°53′ .00201	45° 0′ .00180	46°58′ .00162	48°49′ .00146	50°31′ .00131	52° 7′ .00118	53°37′ .00107	55° 1′ .00096
15	0° 0′ .00444	3° 49′ .00442	7° 36′ .00433	11°19′ .00419	14°56′ .00401	18°26′ .00380	21°48′ .00356	25° 1′ .00331	28° 4′ .00305	30°58′ .00280	33°42′ .00256	36°15′ .00233	38°40′ .00212	40°55′ .00192	43° 1′ .00174	45° 0′ .00157	46°51′ .00142	48°34′ .00129	50°11′ .00117	51°43′ .00106	53° 8′ .00096
16	0° 0′ .00391	3° 35′ .00388	7° 8′ .00382	10°37′ .00371	14° 2′ .00357	17°25′ .00339	20°33′ .00321	23°38′ .00300	26°34′ .00280	29°23′ .00259	32° 0′ .00238	34°30′ .00219	36°52′ .00200	39° 6′ .00182	41°10′ .00167	43° 9′ .00152	45° 0′ .00138	46°45′ .00126	48°22′ .00115	49°53′ .00105	51°20′ .00095
17	0° 0′ .00346	3° 22′ .00344	6° 42′ .00339	10° 0′ .00331	13°15′ .00319	16°24′ .00306	19°26′ .00290	22°23′ .00274	25°12′ .00256	27°54′ .00239	30°28′ .00222	32°54′ .00205	35°13′ .00189	37°24′ .00174	39°29′ .00159	41°25′ .00146	43°16′ .00134	45° 0′ .00122	46°38′ .00112	48°11′ .00103	49°39′ .00094
18	0° 0′ .00309	2° 11′ .00307	6° 20′ .00303	9° 28′ .00297	12°32′ .00287	15°32′ .00276	18°26′ .00264	21°14′ .00250	23°55′ .00236	26°34′ .00221	29° 3′ .00206	31°26′ .00192	33°42′ .00178	35°49′ .00165	37°52′ .00152	39°48′ .00140	41°38′ .00129	43°22′ .00119	45° 0′ .00109	46°33′ .00100	48° 0′ .00092
19	0° 0′ .00277	3° 1′ .00276	6° 0′ .00273	8° 58′ .00267	11°53′ .00260	14°45′ .00251	17°31′ .00240	20°13′ .00229	22°50′ .00217	25°21′ .00205	27°45′ .00192	30° 4′ .00180	32°17′ .00167	34°23′ .00156	36°23′ .00145	38°17′ .00134	40° 6′ .00124	41°49′ .00113	43°27′ .00106	45° 0′ .00098	46°29′ .00090
20	0° 0′ .00250	2° 52′ .00249	5° 43′ .00246	8° 32′ .00242	11°19′ .00236	14° 2′ .00228	16°42′ .00219	19°17′ .00210	21°48′ .00200	24°14′ .00190	26°34′ .00179	28°49′ .00168	30°58′ .00158	33° 2′ .00147	35° 0′ .00137	36°52′ .00128	38°40′ .00119	40°22′ .00111	41°59′ .00103	43°32′ .00095	45° 0′ .00088

Fig. 9.

In this connection Fechner's law of vision is of great importance. This law is briefly as follows:

The sensations produced on the optic nerves vary approximately as the logarithms of the values of the stimuli producing the sensations. In other words, the same change in sensation is produced by increasing from 2 to 4 foot candles as by increasing from 4 to 8, from 6 to 12 and so on. After the desired illumination value has been assumed, there are several methods of procedure, all based on the results of tests of the equipment, and the class of room under consideration.

The total number of effective lumens required is obtained by multiplying the area to be lighted in square ft., by the assumed foot candle value.

Due to the absorption of the reflectors, walls, etc., only a portion of the lumens emitted by the source are effective on the working plane, so that it is necessary to have data on previous tests in order to calculate the total wattage required. Fig 12 shows the effective lumens per watt for various lamps equipped with Holophane reflectors in rooms having either light or dark walls.

Lamps	Reflectors	Walls	Constant
Mazda	Clear Holophane	Light	5.
Mazda	Clear Holophane	Dark	4.
Mazda	Enameled or satin fin.	Light	4.3
Mazda	Enameled or satin fin.	Dark	3.4
Gem	Clear Holophane	Light	2.2
Gem	Clear Holophane	Dark	1.8
3.1 Watt Carbon	Clear Holophane	Light	1.8
3.1 Watt Carbon	Clear Holophane	Dark	1.5

Fig. 12.

The total watts required is found by dividing the total number of effective lumens required by the effective lumens per watt constant.

$$\text{watts} = \frac{\text{(sq. ft. x foot candles)} = \text{effective lumens}}{\text{effective lumens per watt constant.}}$$

The above method is open to two serious objections; first the wide limits over which the wall conditions are defined, and second, the fact that the lumens per watt constants are based on a definite watts per candle of the lamps. As the watts per candle values have been changed from time to time, this is a rather serious objection to the method, as it requires a new set of constants for each change.

If, however, the constants be based only on the percentage of the total generated lumens which is effective on the working plane under given conditions, changes in the lamp efficiency will not affect the values of the constants. A table of such illumination constants is given in Fig. 13.

Lamp.	Equipment.	Ceiling.	Walls.	Constant.
Mazda	Clear Holophane Reflector	Light	Light	.625
Mazda	Clear Holophane Reflector	Light	Dark	.575
Mazda	Clear Holophane Reflector	Dark	Dark	.50
Gem	Clear Holophane Reflector	Light	Light	.57
Gem	Clear Holophane Reflector	Light	Dark	.45
Gem	Clear Holophane Reflector	Dark	Dark	.38
3.1 watt car.	Clear Holophane Reflector	Light	Light	.57
3.1 watt car.	Clear Holophane Reflector	Light	Dark	.45

Fig. 13.

The method of applying these constants is as follows: Multiply the area to be lighted, expressed in square feet, by the desired foot candle intensity. This gives the effective lumens required, which should be divided by the proper illumination constant. The result is the total lumens required to produce the desired illumination. By referring to a table of total lumens given out by each of the various sizes and classes of lamps, (See Fig. 14), it is a simple matter

TOTAL LUMENS GIVEN BY

Rated Watts	MAZDA		TANTALUM		GEM	CARBON	
	100-125 volts	200-250 volts	100-125 volts	200-250 volts	100-125 volts	100-125 volts	200-250 volts
10						21.2	
20						50.3	
25	187.		126.			83.6	
30						96.4	
35							84.
40	319.		221.		162.		
45		302.					
50			277.	252.	207.	174.	
60	498.	402.			249.	208.	171.
80			443.	398.	337.		
100	830.	671.			419.	349.	
120						419.	341.
150	1245.	1006.					
250	2168.	1677.					
400	3470.						
500	4335.	4035.					

Fig. 14

to determine the necessary wattage and the size and number of lamps. Changes in the watts per candle of the lamps necessitate only a revision of the lumens table.

All that now remains is to distribute the lamps according to the proper spacing and height. This is a matter largely governed by experience, although several manufacturers offer valuable suggestions and rules for installing their products. In the absence of these rules it is necessary to use something of a "cut and try" method, checking up each proposed spacing for uniformity by means of the point by point method.

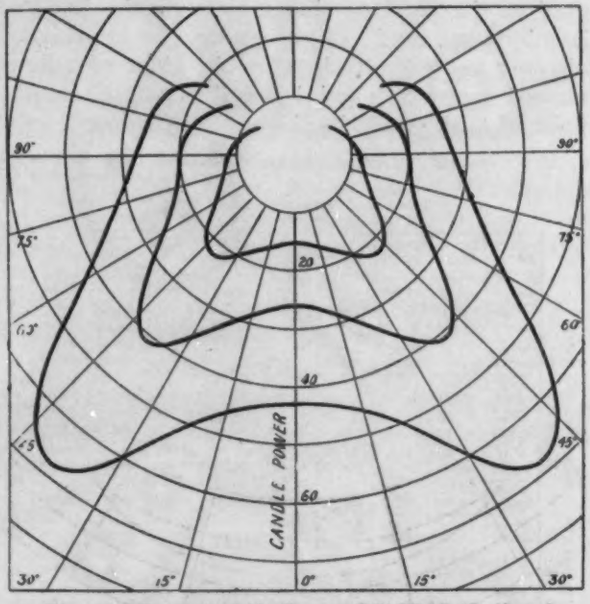


Fig. 15. Characteristic Curves "MAZDA" 35, 40 and 60-watt, 100-125-volt Bowl-Frosted Lamps with Extensive Reflectors.

It is extremely difficult to lay down many definite rules for the spacing of outlets, as this is often determined by the architectural requirements. The spacing of outlets, the height of units above the floor and the type of reflector used are all interdependent, so that each case must be worked out individually.

One requirement should always be observed however; the space to be illuminated should be divided as nearly as possible into squares and one outlet placed at the center of each square.

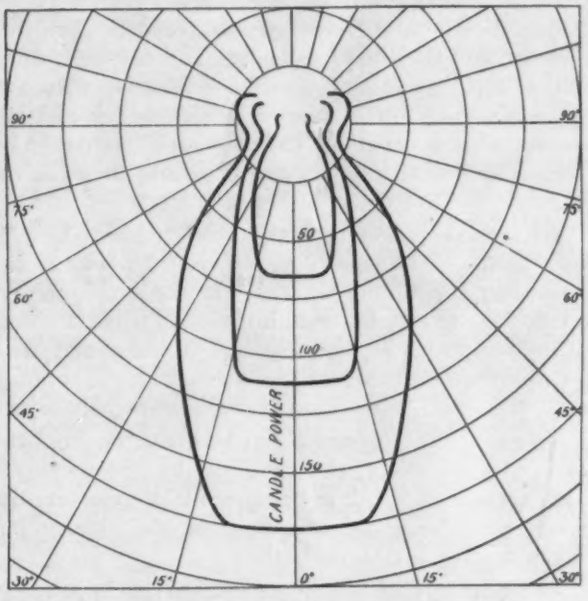


Fig. 16. Characteristic Curves "MAZDA" 25, 40 and 60-watt, 100-125-volt Bowl Frosted Lamps.

The Holophane line of high efficiency reflectors affords perhaps the best example of securing correct heights and spacing by means of the manufacturers' rules. These reflectors are made in three general types of each size, known as extensive, intensive, and focusing. As their names indicate, the extensive type (Fig. 15) gives the broadest distribution of light, the maximum occurring at 45 or 50 degrees from the vertical;

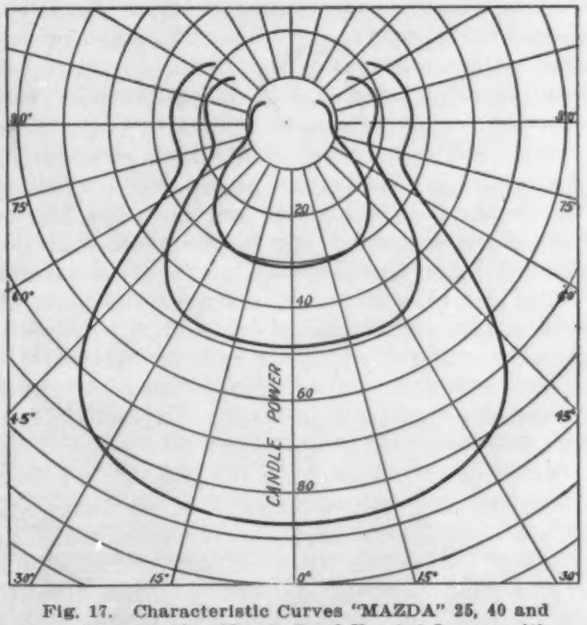


Fig. 17. Characteristic Curves "MAZDA" 25, 40 and 60-watt, 100-125-volt Bowl-Frosted Lamps with Intensive Reflectors.

the focusing type (Fig. 16) gives a maximum candle power out to about 10 degrees, while the intensive type (Fig. 17) comes in between the extensive and the focusing, its maximum occurring out to about 40 degrees. As the uniformity of illumination depends upon the ratio of spacing to height above the plane of illumination, the correct values of these ratios have been worked out and are as follows:

Extensive Type: Height = approximately ½ average distance apart of outlets.

Intensive type: Height = approximately 4/5 average distance apart of outlets.

Focusing type: Height = approximately 1 1/3 average distance apart of outlets.

It will generally be found that it is a necessary use the "cut and try" method to determine which type of reflector is best suited for a given problem, in order to conform with the various requirements of architecture, appearance and possible spacing of outlets.

COMPULSORY WIRELESS FOR VESSELS.

Effective July 1, 1911, all ocean-going vessels carrying more than fifty passengers must be equipped with wireless telegraph apparatus capable of transmitting messages at least 100 miles, according to an act of Congress passed June 24, 1910. The operator must possess a government certificate given after passing an examination at one of the navy yards or naval stations. After January 1, 1912, storage batteries or other auxiliary must be provided in case of any accident to the dynamo.

ON THE CONTROL OF SURGES IN WATER CONDUITS.[1]

BY W. F. DURAND.

The usual treatment of the problem of the surge chamber presupposes a cylindrical form. Certain cases may arise in which a flaring or funnel-shaped form may rather be preferred. In any case the differential equations which indicate the movement of the water do not admit of direct mathematical solution. In consequence, various indirect and approximate methods have been devised. In all such, however, the point of departure has been an assured size of chamber and a consequent determination of the resulting movement of the water. In the present paper the order is reversed. A program is imposed on the water and a surge chamber is found suitable for the realization of these imposed conditions. Taken in this order, the equations by the use of methods of approximate integration and differentiation admit of direct solution without trial and error adjustment. This method is described and illustrated in operative detail, with appendices giving the necessary mathematical discussion.

The relations between the characteristics of the acceleration curve for the water and the resulting form and dimensions of the chamber are discussed in detail and methods are developed for the rapid derivation of a series of chambers from a single type acceleration curve; also, for the determination of a chamber of such form and size as shall produce a non-oscillatory movement of the water in the chamber. Illustrative cases with graphical representation of the quantities involved are given in Appendix No. 3.

[1] Abstract of paper presented at San Francisco Meeting American Society of Mechanical Engineers, June 28, 1911.

WORKMAN'S CONPENSATION ACT FOR WASHINGTON.

Adequate protection for employer and employee, increased safety of industrial operations, sure and certain relief for workers injured at extra hazardous occupations, and their families and dependents, elimination of litigation and consequent saving of retainer's fees and court expenses and regulation by state police powers of dangerous trades and occupations, are some of the advantages claimed for the workman's compensation act, which will become effective in Washington on October 1, 1911.

The theory of the act, which was adopted by the last Legislature, is stated in these words: "The welfare of the state depends on its industries and even more upon the welfare of its wage-earners."

The new law applies to all factories, mills and workshops where machinery is used and foundries, quarries, mines, smelters, powder works, breweries, elevators, docks, dredges, laundries, printing, engineering, logging, lumbering, ship-building, railroad and general building operations, street and interurban railroads, electrical, power and heating plants and steamboats.

One hundred and fifty thousand dollars has been appropriated by the state to bear the expense of administering the law, and Governor Marion E. Hay has appointed a commission to have full charge of the industrial insurance work, including the collection of premiums and the adjustment and settlement of claims. The commission, which is composed of George A. Lee of Spokane, representing the legal profession, chairman; C. A. Pratt of Tacoma, for the manufacturers and employers, and J. H. Wallace of Seattle, for the workingmen, has power to create new classes and establish new rates.

The law provides that each of the industries shall contribute a certain percentage of its pay-roll to an accident fund, from which various sums are paid out for total or part disability or on death to the family and dependents of the injured workman, the expense of handling the fund being borne by the State. Injured workmen, their families or dependents, cannot recover by law except where the injury is caused by the intent of the employer, in which case the workman or his family may recover not only the sums due under this act, but may sue for any excess of damage over those amounts.

Where a workman is injured because the employer has neglected to observe the safeguards required by law or by the regulations of the department, the employer must pay 50 per cent more than the fixed amounts. Where the workman intentionally injures himself he receives no benefit.

The industries of the state are classified and certain premiums fixed for each class. The employers are required to pay three months' premiums into the state treasury on or before October 1, 1911. After December 31, 1911, monthly payments are required, provided, however, that if any industry has a sufficient amount on deposit with the state to take care of its accidents no further payments shall be required.

Each industry is responsible only for the accidents occurring in that class. It is intended that the accident fund shall be neither more or less than self-supporting. The rates are subject to readjustment, depending on the number of accidents and the need for compensation of injured workmen.

Employers are required to report accidents promptly, and their books, records and pay-rolls must be open for inspection by the commission. Refusal to permit inspection is made a misdemeanor and the employer also is penalized $100 for each offense, to be collected by action in court and paid into the accident fund.

Misrepresentation in his pay-roll makes the employer liable to 10 times the difference between the correct and the wrong figures. If the employer refuses or fails to pay his monthly assessments, a workman injured in his service may sue in the courts with the employer's defenses of "fellow-servant," "assumption of risk" and "contributory negligence" abolished.

No part of the premium can be deducted from the ages of the workman, the violation by the employer of this section of the law being made a gross misdemeanor, punishable by one year in the county jail or by a fine of $1000, or both.

The schedule of payments for various injuries is as follows:

In the event of death, expenses of burial, $75; payments to widow or invalid widower, $20 a month while unmarried, $240 in a lump sum on remarriage of the widow for each surviving child under 16, $5 a month, monthly amount limited to $35; if no widow or widower survives, $10 a month to each child under 16 years. The same rule applies to children who become orphans by death of surviving parent, with monthly limit of $35. Dependents will be paid 50 per cent of the average monthly support formerly received from the deceased workman, limited to $20 a month. Parents of deceased unmarried workmen receive $20 a month up to time deceased would have been 21 years of age.

When totally disabled, loss of both arms or one leg and arm, sight, paralysis or other injury preventing the workman from doing any work, entitles him to $20 a month if unmarried; if supporting wife or invalid husband, $25 a month; if the husband is not an invalid, $15. For each child under 16, an additional $5 a month up to a total of $35. In case of death of the totally disabled workman, the widow or widower received $20 a month until death or remarriage and $5 a month additional for each child under 16. Orphan children receive $10 a month.

When partly disabled by the loss of one foot, leg, hand or arm, eye or fingers, the workman will receive a certain cash lump sum up to $1500. The loss of one arm at the elbow is made the maximum injury and the payment for other injuries is scaled down by the commission. If the injured workman resides or moves out of the State the commission may lump the monthly payments, not to exceed $4000, based on the American mortality table. Any decision of the commission is subject to appeal in the superior courts.

RESPONSIBILITIES OF ELECTRICAL ENGINEERS IN MAKING APPRAISALS.[1]

BY H. M. BYLLESBY.

The electrical engineer must recognize that in addition to the multiplicity of duties he has been called upon to discharge, he is now confronted with a new class of responsibilities from which he cannot shrink. To these responsibilities he must give the best that is in him of experience, of fair mindedness, of wisdom and of justice.

In the world at large and particularly in the United States we appear to be in the midst of a period of flux and change. Old methods and old standards are passing away; new methods and new standards are demanded. With the marvelous progress of the civilized world since the last great economic and social changes, it will be a shame if the present crisis fails of a solution more rational and with less hardship and destruction than has attended previous solutions of economic and social crises. Out of the present controversies we must endeavor manfully and fairly to bring a condition of justice to all concerned and in our share of duty in these matters we must make every effort to be intelligent and not to be found wanting in fair dealing and honesty between man and man, between corporations and the public and between governing bodies and corporations. Principal among these new responsibilities which are being rapidly thrust upon our profession is making appraisals to determine the value of the property of a public service corporation.

These values, in accordance with the unmistakable present trend of the times, are to be made a basis upon which or from which are fixed the maximum rates which these corporations are to be allowed to charge for service rendered. There is much discussion taking place on replacement values, reproduction values, depreciation values, and intangible values. In the majority of cases the property to be appraised represents a continuing growth or a construction period from its inception. Much of the construction work we are called upon to value is concealed from view, such as foundations of buildings, foundations for machinery, submerged portions of hydraulic construction, conduit systems and gas pipes. In every case the structures or plants have been built in what is conventionally termed a "piecemeal" fashion. Almost every public service corporation has started from a small beginning and added to its plant continuously, and the finished structure today represents construction work which has been continued from the time the original property was created. In meeting the questions which the spirit of the times is demanding answers to, very properly a demand is made by all parties to the controversy that absolute and entire frankness and complete candor pervade the negotiations. Properly a period has been put to the practice of dissimulation and trickery and misrepresentation on the part of the public, the governing body, and the corporation. From a long experience I can state for my part that trickery and dissimulation and unfair dealing in the past have been fully as great on the part of the public and the governing bodies, if not greater, than on the part of the corporations. Following this proper demand for candor, I desire to call the attention of my fellow members of the American Institute of Electrical Engineers to the painful fact that it is extremely rare for a professional engineer or constructor in any branch of industry, in any branch of construction, to estimate the cost of such construction with accuracy and that the practically uniform experience has been that all such estimates have proved woefully less than the cost of the completed project.

I believe we should be candid and frank on the subject. Every one of us whose duties require him either as a principal or in an auxiliary capacity to be responsible for the furnishing of capital to build any given public service construction or to develop any given enterprise, knows full well from a long and painful experience that unless he provides for indefinite excess charges or leaves some other avenue of escape, the enterprise or construction when finished will be burdened with a floating debt which seldom is of small relative proportion. This debt is the difference between the estimated cost of building the undertaking and the actual cost as developed after the event. I believe there has not been a considerable piece of public service construction in recent years where the finished cost complete has not overrun the estimated cost by a minimum in a few cases of 10 per cent to 15 per cent to a maximum in a majority of cases of a dangerously large percentage which not infrequently has gone to an excess cost of 100 per cent. All experienced contractors will bear out the statement I have made. The comparatively few contractors who finish their career with more money than they started with, or with more money than they themselves started with and without leaving their banks or guarantee companies in the lurch have an experience of profit and loss, the loss on one job the profit on another. These men have learned their lesson and today they will only with the greatest reluctance take a contract which, under an enforceable bond, compels them to fully complete any large given piece of work for a given sum of money. Where they are forced to take any part of their contract in this manner they very properly, I think, provide for extras at a given rate, expecting that their loss on the lump work will be made up by the profit from the extras. This is too thoroughly understood to admit of any discussion.

I shall not attempt to go into detail of this well-nigh universal experience of underestimating. A large total excess cost of a completed undertaking may be represented by a small overrun in the cost of the purely physical construction and an omission of large material collateral expenditures which are part and parcel of the completed project. The shortage may be due in this view of the case to an ignorance on the part of the individual furnishing the budget to be provided; ignorance which results in overlooking a material and proper part of the cost of the completed project because it was not strictly physical construction. The overrun resulting in the floating debt therefore, in many cases, may be quite largely made up of the omission of those necessary costs which in the discussions of the times are termed "intangible values." But no matter in what direction the shortage occurs, no matter whether on the strictly physical part of the construction

[1] Extract from address at annual convention A. I. E. E., Chicago, June 27, 1911.

or from forgetfulness of or ignorance of the proper costs under the head of intangible values, the facts remain substantially as I have stated in my premise.

How careful, therefore, how fair minded and liberal should be the point of view of the professional engineer in appraising the value of another man's or another corporation's property for the solemn and serious purpose of having based upon his appraisal the return which that man or that corporation is to be allowed to receive upon the investment. It is unfair that an engineer or appraiser who recognizes at the bar of his own conscience that his own estimates have been uniformly overrun should make his appraisals without taking into consideration and manfully applying to his estimate his own factor of individual inaccuracy, his own personal factor of nearly unfailing underestimating.

If the profits to be allowed public service companies were to be on a broad and liberal basis this feature would be of less importance. The spirit of the times, brought around partly by mistakes, by selfishness, by unfairness, on the part of all parties to the contract, the tendency of the times, actuated to a degree by certain irresponsible magazine writers, magazines and papers, and by certain politicians, all tend to reduce the return of the public service corporation to a low point. At best it would indicate, allowing the public service corporation after paying its operating expenses and depreciation charges, a distributable sum equivalent to from 7 per cent to a possible 10 per cent upon its reproduction value, the higher percentage being rather hoped for than indicated. It becomes plainly evident, therefore, how grievous a hardship may be worked upon corporations if the appraisal of their property is as much below the real value of their property as the average estimate of the engineer has proven in the past. I think the situation is one of the most momentous which confronts our profession today. A large part, I presume 90 per cent, of the activities of our profession have resulted from the continuing growth and existence and development of public service corporations. If these corporations through under appraisals or drastic regulations are discouraged and cease their active aggressive growth of the past it will be immediately reflected in the lessening demands made for the services of the members of our profession.

Capital is a peculiarly mobile commodity. Capital will flow from one part of the world to another in accordance with the inducements which are offered it. Capital will leave any given field with great speed if it finds that it is receiving an unfair or unjust recompense or other fields offer greater inducements. Without capital, modern enterprise is impossible. The most beneficial use of capital is to have it employed in developing new enterprises, extending existing enterprises which in turn develop and add to the wealth of the communities served. In our extending enterprises we afford profitable employment for increasing population and we ameliorate the conditions of human existence. The profession in which the members of this association are engaged could not exist at all if capital withdrew its support from enterprises depending upon the genius and ability and conscientious effort of the electrical engineer.

I urge upon all of you to carefully consider this subject, to avoid the influence of the idea that the professional engineer can get along without the services of capital. Capital on its part must treat the public, the laboring man and the professional man with fairness and liberality, with more fairness and liberality than it has in the past. On the other hand, the professional man who from the nature of his calling and its dignity carries a large influence in the community in which he operates must not forget the close co-relation between brains, labor and capital, and neither through professional indifference or professional jealousy allow himself to give capital an unfair hearing or an unjust decision.

We must avoid the fallacy that only the physical portion of a corporation's property is entitled to a value, a fallacy which has led many engineers, many business men and many corporations to disaster. The facts being that beyond the naked physical value there is required a very large and material sum to change that naked inert mass of physical construction into a live, progessive, earning entity. The omission of the cost of making a going concern in addition to its naked physical value has been the root and cause, in my judgment, of a large proportion of the disasters which have overtaken enterprises in the field in which we operate.

These remarks and more to the same effect apply to the question of intangible values and when called upon to deal with these matters I hope the fullest consideration will be given to them. These intangible values generally embrace interest during construction, accidents and insurance during construction, engineering charges, supervision charges, and they should include proportionately, the tremendously large sums expended by public service corporations in developing the business, in educating the public, and producing a sale of their commodity, whose reflex effect in subsequent reduction of the operating charges should be considered as proper cost in the value of the property. Further proper charges, of an absolutely legitimate nature, to the intangible value account include the legal expenses of organization and of putting the enterprise on its feet, the discounts on securities sold or brokerage paid for finding of the capital and particularly in the case of the older companies, the large sums spent in absolute good faith in what was really a period of experimenting to obtain the best apparatus, the best systems, and methods adapted to the requirements of the company happening to be in question. Due regard should always be given to the added cost of piecemeal construction which has been an unfailing incident of all of these corporations. In all fairness it should include the losses due to obsolescence and the discarding of workable machinery long before its life had been exhaused, this discarding being for the purpose of keeping pace with the times and in the last analysis for the better serving of the public.

There is a tendency, I hope a diminishing tendency, to be unfair to public service corporations and to be entirely oblivious of the hazards and risks they have incurred in the building of their business and to be forgetful of the profound importance and great

benefit they have been to the communties they serve.

A recent example and a very pertinent one of this tendency to be unfair has occurred in the appraisal of the value of one of the largest utilities in a large western city. The appraisal was for the purpose of determining the proper reproduction or replacement value of this utility. The formula was rather clearly understood as pertained to the physical property, deductions were to be made and were made for the accrued depreciation, allowances were made for what had evidently been unusually expensive piecemeal construction and matters of that description, the theory being that as regarded the physical value of this property, its appraised value would represent what it would cost to reproduce the property in its present condition.

In general this formula was carried out fairly until it was found that a material part of the distributing system of this company was now under paved streets, but that due to the enterprise or necessity of the company in the past a part of its underground system had been placed in the streets in question before they were paved; that is, the paving above this underground system on a material portion of the company's property had taken place after its distribution system was in the ground. The ruling of the body making this appraisal was that this company was not entitled as a part of its value to the cost it would have been put to of placing this distribution system under the paved streets and the difficulty of sustaining this ruling is plainly evident from the fact that wherever this company has put its distributing system underneath paved streets or where it is doing it today, the cost of that paving has applied to this company and is allowed as a part of the value of their plant. It would be hard to conceive of a more direct effort to discourage enterprise than this particular ruling. If the company had waited to put all of its distributing system under the paved streets until the paving was down and had then ripped it up and buried its distributing system they would have been allowed the cost of taking up and replacing the paving. Because they did it in advance they were not allowed that cost. This particular city is far better off from the course which that company pursued because its pavement over that particular portion of the distributing system was not injured by being taken up to put the distributing system underneath it.

We all believe we are approaching a far better understanding between all parties concerned on these questions than has existed in the past. The effort of all of us must be by conscientious effort, by candor and sincerity to bring around this better condition. However, with the tendency of the governing bodies to make decisions such as I have just referred to, how extremely important it becomes for the engineer entrusted with the making of an appraisal to be sure that he has not underestimated, to be sure that so far as his intelligence and authority go he gives to the property under consideration the benefit of all the value he believes it is entitled to, both physical and intangible.

A highly instructive and deeply intellectual article on one extremely important detail entering into this subject of appraisals is before the association in an article on that subject by Mr. Henry Floy, who approaches the matter of his very able paper from an ample preparation and a long experience.

In closing I desire to urge upon all of you a sense of the responsibilities now being thrust upon us; to urge upon you a sense of the dignity of our calling, and to express the hope that with the usual opportunities possessed by the members of this organization for forming a basis for a proper measure of the questions of values; that we approach these subjects with high intelligence, with a profound sense of the responsibilities resting upon us and with appreciation of the fact that in the combination of capital, the public and professional engineers, no hardship can be worked to any one of the three without inevitably producing its full quota of disaster to the others.

FLOW OF STREAMS AND THE FACTORS THAT MODIFY IT[1].

BY D. W. MEAD.

The quantity and regularity of stream flow and its variations are matters of much importance in hydraulic engineering, and equally so to many of the business interests and enterprises. Public attention has recently been called to various questions relative to water power and internal navigation, while questions of water supply, drainage, and flood protection are no less important to the public welfare. One of the most important elements in the solution of all of these problems, and of many others almost equally important, is the condition of stream flow or runoff. The application of storage for the prevention of floods and for the promotion of uniformity of flow for navigation power and water supply purposes, has been much discussed, and many opinions have been expressed as to its possibility, desirability, and value. The value of forests for increasing or equalizing stream flow has been widely discussed, and opinions greatly at variance have been expressed both favorable and unfavorable to such influences. It has also been suggested that water powers of the state be taxed to provide for the reforesting of the head waters of the streams on the theory of direct benefit, and bills providing for such a tax have been offered in the legislature. The arguments that have been presented to sustain the various opinions that have been expressed on many of these questions have seldom been satisfactory or conclusive, except to their authors. Much incomplete and half-considered data have been offered to sustain the contention of the advocates of both sides of many of the debatable questions, and in few cases have the arguments been based on such complete data that the conclusions have not been open to serious question. In many cases the advocates of various theories have apparently sought only for such data as would support their personal views, and have minimized or ignored the data that might suggest a contrary view of the question at issue.

It has appeared to the writer that while most of the questions at issue are exceedingly complicated, and while the data available for the solution of these problems are more or less incomplete and unsatis-

[1] Extracts from Bulletin No. 4251, University of Wisconsin.

factory, yet a careful examination of such data, in considerable detail, on scientific lines might lead to definite and well substantiated conclusions, at least in regard to a limited area. With this idea in view, the writer has made a somewhat detailed study of this subject with special regard to the conditions prevailing in the State of Wisconsin; and while the data examined and considered are too numerous to present in print, he has endeavored to select certain typical locations from which data were available and has endeavored to present the study of the conditions that prevail therein in sufficient detail to warrant the opinions expressed in his conclusions. In most, if not in every case cited the data on which the opinions rest are presented so completely that the rationale of his conclusions can readily be understood. Where the data have not been presented, the source from which they were obtained and from which they can readily be verified has been stated.

The writer would by no means have it understood that he has not had definite opinions on many of these subjects, but he has approached this study with an open mind and with a strong desire to ascertain the truth, in whatever form it might appear. His personal interest in hydrological science and in practical hydraulic developments makes it most important to him that the truth be determined if possible.

If forests will improve the regularity of streams and prevent floods, if they will conserve and increase the low water flow, if they will prevent denundation and increase the depth of streams, it is most important that these facts be known. If, on the other hand, such effects are purely imaginative or unimportant, it is equally important that that fact be known so that unjust laws and useless expense shall be avoided.

If it is practically possible to construct reservoir systems on the head waters of some or all of the streams of the state, and, by storage, to economically regulate their flow and radically increase the available low water power of the streams and their availability for navigation purposes, such facts and their limitations are of great importance to the citizens of the state. The effects of the draining of swamps and of wet land, the cultivation of agricultural lands, and of various other artificial changes in normal conditions should also be known and appreciated in order that their effects may be obviated if harmful, or emphasized if beneficial, to as great a degree as possible.

The Problem of Runoff.

The portion of the rainfall that is discharged in the surface flow from a drainage area is termed the "runoff" from that area and may occur, in the case of water flowing from areas of considerable magnitude, as a definite stream or, when small areas are considered, merely as the surface drainage not confined to a definite channel.

A brief examination of the subject shows that the factors that modify and control runoff are very numerous and differ in intensity and in effect with every drainage area considered. While the relative runoff from each area will agree more or less closely with that of other areas on which the conditions are similar, there are always variations which occur in these conditions that make them so dissimilar as to create greater or less difference. The causes of such differences are not always manifest as it is often impossible to obtain a sufficiently exact knowledge of the detailed conditions prevailing over an entire drainage area so that more than approximate conclusions can be drawn. Nevertheless, a discussion of this subject, based on scientific considerations, may so clearly set forth the principles involved in any specific case that the dominating influences can be clearly seen and the extent of the influence of any particular factor, if important, may be quite clearly realized and appreciated.

Resume of the Factors That Modify or Control Runoff.

1. Precipitation—
   - (a) Whether it occurs as rain or as snow.
   - (b) The amount of each, and the total annual precipitation.
   - (c) Its distribution throughout the year.
   - (d) Its intensity or manner of occurrence.
   - (e) The character of storms, including their direction, extent and duration.
2. Temperature—
   - (a) The variations of temperature on the area.
   - (b) The relation of extreme temperatures to the occurrence of precipitation.
   - (c) The accumulation of snow and ice, caused by low temperatures.
   - (d) The occurrence of low temperatures causing the freezing of the ground surface at times of heavy spring rains, resulting in excessive runoff.
3. Topography of the Drainage Area—
   - (a) As to whether the surface is level or inclined, and the degree of inclination.
   - (b) As to character of area, whether smooth or rugged.
4. Geology of Drainage Area—
   - (a) Whether pervious or impervious.
   - (b) If pervious, whether such pervious deposits are (a) shallow or deep; (b) level or inclined; whether the outlet or point of discharge of the pervious deposits are (c) in the lower valley of the same river, or (d) in valleys of other rivers, or in the sea.
   - (c) As to the condition of the channel of the stream, whether (a) pervious or impervious; (b) whether or not the bed contains more or less extensive deposits of sand and gravel, permitting of the development of a more or less extensive underflow.
5. The Condition of the Surface—
   - (a) Whether bare or covered with vegetation.
   - (b) Whether in natural condition or cultivated.
   - (c) Nature of vegetation, whether grassland, cultivated crops, or forests.
6. The Character of the Natural Storage on the Drainage Area—
   - (a) Nature and extent of surface storage, consisting of lakes, ponds, marshes, swamps.

(b) Nature and extent of ground storage, consisting of gravel, sand, and other similar pervious deposits.

7. The Nature of the Drainage Area Considered—
   (a) As to size, whether large or small.
   (b) As to shape, whether long and narrow, or short and broad.
   (c) The location of the area relative to prevailing winds.
   (d) The direction relative to the path of storms.

8. Character of the Stream and Its Tributaries—
   (a) As to slope or gradient, whether flat or inclined.
   (b) As to falls and rapids on the stream.
   (c) As to the section of the stream, whether deep or shallow.
   (d) As to the arrangement of tributaries, whether joining the main stream at various points along its course or concentrated in a fan-like arrangement at a more or less common point of discharge.

9. The Artificial Control of the Stream—
   (a) As to dams and storage reservoirs on the drainage area.
   (b) As to the restrictions of the river sections by dikes and levees.
   (c) As to the obstruction of the stream by piers, abutments, and other encroachments in or adjacent to the waterway.

10. The Artificial Use of the Stream—
   (a) For irrigation.
   (b) For water supply.
   (c) For the supply of navigation canals.
   (d) For artificial storage and regulation of the same.

11. Character and Extent of the Winds on the Drainage Area—
   (a) As to their intensity and direction.
   (b) As to the modification of the same by mountains and forests.

12. Ice Formation—
   (a) As modifying the winter flows of the stream.
   (b) As to the formation of ice gorges and their accompanying floods.

Conclusions.

From a detailed study of the general relations to runoff or stream flow conditions in Wisconsin, the following conclusions can be clearly drawn

1st. That in general the quantities and variations of stream flow are due to a large number of concomitant factors, some fixed and some variable, each having an influence in proportion to its own character and intensity and the relative character and intensity of every other factor. The combinations of these factors are so numerous, and differ so widely even on a single drainage area, that no problem of flow can be determined even approximately from a consideration of the factors themselves except by means of a comparison with the actual relative effects under circumstances more or less similar to those under investigation.

3rd. That the mean annual stream flow on any stream, and the variation in the stream flow throughout the year, depend mainly on the quantity and distribution of the precipitation, modified by temperature conditions.

4th. That extreme floods are due to the simultaneous occurrence of temperature and precipitation conditions, favorable to excessive runoff, and that no practicable works of man, such as drainage works, reservoirs, or reforestation, can materially affect the flood peaks on the larger Wisconsin rivers.

7th. That the uses for which reservoir systems may be constructed are essentially antagonistic and that the specific use to which they should be applied must depend on the local conditions which may modify the relative values of the services which they can fulfill.

9th. That if forests have any effect on stream flow that can be assigned a practical value, such effects must be manifest by an actual change in the conditions of flow when deforestation occurs, and that if deforestation is not accompanied by an actual change in the stream conditions, the effects are entirely theoretical and practically valueless.

12th. That while theoretically forests will decrease the amount of precipitation reaching the earth's surface—thus decreasing the water supply of streams—and, under certain circumstances may afford a limited storage which may aid in the regulation of stream flow, yet the examination of the actual flow of the streams of Wisconsin shows no indication of such effects.

13th. That if any effects on stream flow have resulted from deforestation they have been entirely counteracted and obscured by the drainage of marshes, the clearing of farm lands, the second growth of timber and brush, or other similar occurrences.

14th. That so far as all evidence examined is concerned, there is nothing to show that the planting of forests in Wisconsin would in any way add to or take away from the quantity or regularity of stream flow, or decrease the flood heights.

15th. That therefore the reforestation of the headwaters of Wisconsin streams cannot be expected to add to the quantity or regularity of the power which may be developed on any stream, or to change or improve the flow of the stream for any other useful purpose.

Finally:

16th. That the changes and variations in the flow ratio in Wisconsin rivers are due to undetermined factors which modify the precipitation-runoff relations as similar indeterminate factors modify the amount and distribution of the annual rainfall. Such phenomena occur in cycles and are not found to be continuously favorable or unfavorable to the quantity or regularity of stream flow.

17th. That the flows of Wisconsin streams as shown by their total annual, mean annual, and maximum and minimum flows, have neither increased or decreased during the last thirty-five or forty years except as such increase or decrease has been caused by the annual and seasonal variation in the quantity and distribution of the rainfall, together with the modifying effects of the accompanying temperature.

JOURNAL OF ELECTRICITY
POWER AND GAS

PUBLISHED WEEKLY BY THE
Technical Publishing Company
604 MISSION STREET, SAN FRANCISCO

E. B. STRONG, President and General Manager
A. H. HALLORAN, V. P. and Managing Editor
ROBERT SIBLEY, Treasurer and Editor in Chief
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EASTERN OFFICE, 140 NASSAU STREET, NEW YORK

TERMS OF SUBSCRIPTION

United States, Cuba and Mexico	per year,	$2.50
Dominion of Canada	"	3.50
Other Foreign Countries within the Postal Union	"	5.00
Single Copies, Current Month	each	.25

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas." Weekly.

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Surge Pipes

The control and, if possible, the prevention of surges in high head pipes is of vital importance in the operation of water power plants. Surges bring about an erratic power supply by disturbing the turbine governors and they may even burst the pipe by water hammer, so familiar when domestic water supply is quickly shut off. The sudden stoppage of a column of hundreds of tons of moving water greatly strains the strength and elasticity of the pipe and sets up this vibratory motion known as a surge.

For many years this was overcome by an ample factor of safety for the pipe and by providing outlets which could not be closed within a certain predetermined time, due operating care also being exercised to avoid its causes. As the enclosing conduit is lengthened the problem becomes more complex, usually being solved by making an outlet as close to the point of sudden stoppage as the conditions of the installation will permit. This outlet takes the form of the standpipe or surge-pipe so frequently seen in modern plants.

A safety valve is supplied with the surge pipe to afford relief from the possibility of bursting the pipe. The sudden diminution of the outlet flow will set up a surge disturbance unless some sort of by-pass is provided to automatically discharge an amount of water proportional to that which is shut off in a given interval of time. It is impractical to design such a device for every and all conditions.

In a paper presented at the San Francisco meeting of the American Society of Mechanical Engineers this week, Professor W. F. Durand of Stanford University has worked out a method which permits direct calculation of the elements of a surge chamber to meet any predetermined program of time-acceleration of water in the conduit. Contrary to the precedent of a cylindrical pipe his mathematical deductions suggest a funnel shape. This theory has been successfully applied to practice in the case of one of the power plants of the Los Angeles aqueduct, whose closed conduit consists of a tunnel and pipe over seven miles long, having an area of one hundred square feet and a maximum flow of about one thousand cubic feet per second. Figures are unnecessary to convey an idea of the enormous mass of water whose movement must be accelerated or retarded in governing this plant and the method of calculation which Professor Durand has devised is of the greatest interest to engineers.

His work is a long step forward in the rationalization of hydraulic technics, which has long suffered from too little theory. The laws which govern the theory water flow are less clearly understood than those in almost any other branch of engineering. The formulae are empirical and based on data appertaining only to special cases and the methods are rule-of-thumb. Having passed through the period of deductive development, "its facts being reproducible in the mind without constant recourse to observation" it is now ready for its formal development, whereby facts are systematized so as to be reached and pictured with the least intellectual effort.

PERSONALS.

Frank H. Ray is at San Francisco.

Thomas Mirk of Hunt, Mirk & Co., has returned from a trip to San Diego.

C. E. Groesbeck, vice-president of the H. M. Byllesby Company, has returned to Portland, Ore.

Wynn Meredith is consulting engineer for the Sooke Lake water supply project of the city of Vancouver, B. C.

B. C. Carroll, general agent of the Pacific Telephone & Telegraph Company, spent the past week at Los Angeles.

A. G. Wishon, general manager of the San Joaquin Light & Power Corporation, was at San Francisco during the past week.

Carl L. Wernicke, in charge of the Westinghouse Electric & Manufacturing Company's Portland office, is at San Francisco.

Thornwell Mullally, assistant to President Patrick Calhoun of the United Railroads, made a trip to Cleveland, Ohio, last week.

B. C. Condit, who has been engaged in electrical engineering investigations in Oregon during the past few months, is at San Francisco.

C. M. Bliven, Seattle manager for the General Electric Company, has returned from the meeting of the supply men at San Francisco.

J. H. Cain, who is at the head of the Novato Light & Power Company of Novato, was a San Francisco visitor during the past week.

Elam Miller, commercial engineer with the Pacific Telephone & Telegraph Company, is making a month's trip throughout the East.

O. H. Ensign, electrical engineer with the Reclamation Service, with offices at Los Angeles, is at Boise, Idaho, examining the Arrow Rock project.

E. D. N. Lehe, who had electric power interests in the neighborhood of Dixon and Martinez, has left California for a European tour with his family.

A. M. Hunt returned to his San Francisco office last Monday, after spending several weeks at New York and Eastern manufacturing centers.

J. A. Cranston, the Pacific Northwest district agent for the General Electric Company, with headquarters at Portland, was at San Francisco during the past week.

A. C. Balch, who is interested in the Pacific Light & Power Company and other Huntington corporations in Southern California, was a recent San Francisco visitor.

H. H. Noble, president of the Northern California Power Company, has returned to his San Francisco office after an inspection tour of the entire hydroelectric system, including the new 20,000-h.p. Coleman plant, which is nearing completion.

E. W. Florence, who was formerly connected with the Pacific Gas & Electric Company at Fresno, has gone to Redwood City as manager of the Redwood district, succeeding L. H. Newbert, who has been placed at the head of the company's new business and appliance department with headquarters at San Francisco.

S. S. Philbrick, manager of the Lewiston & Clarkston Improvement Company, which has an extensive electric power transmission system in operation, is at San Francisco from Clarkston, Wash. The company has hydroelectric plants at Pomeroy and Asotin in Washington and a steam plant at Clarkston. Lewiston, Idaho, and a number of other cities are supplied with electric power.

Sidney Sprout has returned to San Francisco from Siskiyou county, where he is superintending the engineering work on the new 35,000-kilowatt hydroelectric installation of the Siskiyou Light & Power Company. Three generating units will be installed. The power site is on the Klamath River, near Thrall. In addition to tieing in with the company's existing power transmission lines from the Fall Creek power station the new lines will be extended to Klamath Falls where the company recently purchased a local electric plant.

Samuel J. Taylor, who resigned as secretary and treasurer of the Oakland Traction Company, the Key Route, and the California & East Shore Suburban railways, has accepted the position of financial secretary of the Peoples Water Company. Frank W. Frost, for nineteen years connected with the Oakland Traction and Key Route systems, succeeds Taylor. Mr. Frost, at the time of the Smith-Tevis merger, went to the San Francisco offices of the United Properties Company. Angus Clark, who has been with the traction company for the past four years, will succeed Mr. Frost as assistant secretary.

W. W. Briggs has been appointed assistant sales manager of the Westinghouse Electric & Mfg. Company, with headquarters at San Francisco, and jurisdiction over the Pacific Coast. This announcement comes as a pleasant surprise to Mr. Briggs' many friends on the coast, where he has been active in the electrical business ever since 1886, when he began as shop boy in the arc lamp repair department of the California Electric Light Company. Later he became connected with the Electric Improvement Company, as competitors of Central Lighting Stations in San Francisco, leaving the company to go to Idaho as electrician for a mining company in 1893. In 1896 he returned to San Francisco and joined the sales force of the Fort Wayne Electric Company, leaving there to join the sales department of the Westinghouse Electric & Mfg. Company, on January 1, 1899. He was made district manager of the Westinghouse Electric & Mfg. Company in May, 1905, which position he has held to date. His new duties will be outlined by the sales manager at Pittsburg and his time will be occupied in the development of the company's business in California, having general oversight of the San Francisco and Los Angeles offices.

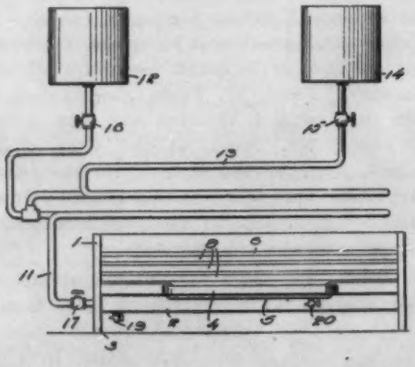
TRADE NOTES.

The Empire Construction Company has opened offices in the Exchange Building, Seattle, Wash., to engage in electrical contracting and engineering work. J. F. Ne Page and V. S. McKenney are interested.

The United Railroads of San Francisco have recently converted their Mason and Washington Power Station from steam to electric drive, so that all their cable lines are now motor driven. The Castro and Pacific Avenue Stations are operated with D. C. motors, while at Mason and Washington Station the new installation is all A. C. apparatus, the motors being 600 h.p., 400 r.p.m., 440 volts, the controllers reversible and the characteristics of the motors along with grid rheostats are such as to permit running for one-half hour at one-half speed and full torque in either direction. The speed of all cables has been increased about 3 per cent and owing to the practically constant speed of the motor the cables travel at a much more uniform speed now than with the old equipment, it being impossible to control the steam engines with less than 5 per cent. The equipment has been installed by W. T. Bivins, Chief Engineer Electrical Equipment.

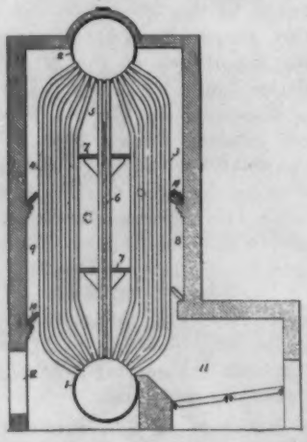
PATENTS

995,511. Crude-Oil Burner. John C. F. Woodworth, Phoenix, Ariz., assignor to I. J. Lipsohn, Phoenix, Ariz. An oil burner, comprising a receptacle, a burner plate arranged at an angle in the receptacle to provide a mixing chamber between the plate and the bottom of the receptacle, said plate



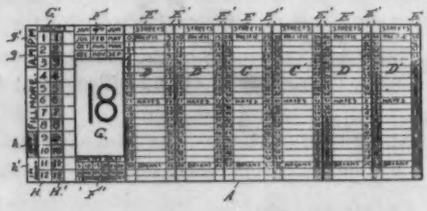
having perforated ribs formed thereon, a perforated pipe mounted in the chamber and having an end projecting from the casing, fuel supply coils extending above the burner plate and connected with the perforated pipe, and means for controlling the flow from the coils to the pipe.

995,523. Water-Tube Boiler. Wilfred D. Chester and Henry B. Rust, Pittsburg, Pa., assignors to The Babcock & Wilcox Company, Bayonne, N. J. In a water-tube boiler having horizontal water and steam and water drums, a group of straight tubes adjacent to a vertical plane passing through the center line of the two drums, groups of bent tubes on either side of said group of straight tubes placed at a distance



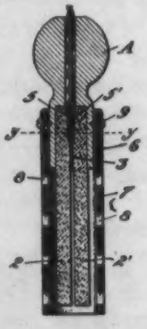
from the said group of straight tubes a sufficient distance to allow a man to enter the said space, a wall between the straight tubes and supported by them, said wall resting on the water drum and extending from side wall to side wall, and horizontal baffles supported by said vertical wall and the straight tubes and extending from the group of straight tubes toward the group of bent tubes, and inclined baffles extending from the front and rear walls to the bent tubes.

995,917. Transfer-Ticket. Frank W. Shean, San Francisco, Cal. A street railway transfer ticket comprising a body having on the face thereof a plurality of independent columns each containing in sequence the names of the transfer points along the route of the car, hour indications on the transfer for designating when punched the hour of the car's departure, numerical indications at the head of each of the columns on the ticket, one of which is adapted to be punched to indicate the time in minutes of the departure of the car, the body of said transfer being also provided with numerical indications adjacent the names of the several transfer points in each column, the numerical indication opposite any of such



transfer points in the column which has been punched to indicate in minutes the time of the departure of the car indicating in conjunction with the hour indication on the transfer which has been punched the time limit for the use of the transfer at such transfer point, said body being also provided with a table of numerical indications thereon adapted when punched to vary the reading of the indications opposite the transfer points to the extent of the number punched.

995,591. Electric Heater. Thomas E. Fogalsang, San Francisco, Cal., assignor to Joseph A. Moross, San Francisco, Cal. An immersion electric heater comprising a handle having a tubular end forming a chamber, a pair of exposed, carbon



electrodes each having one end fixed to the chamber of the handle, means for holding the electrodes apart to provide an intermediate water heating space, and a perforated inclosure for the electrodes, said inclosure being fixed to the tubular end of the handle.

995,778. Electric-Lighted Finder. Frank L. Fitch, Santa Cruz, Cal. A finder comprising a barrel, a removable cap at one end thereof, an electric light bulb fitted to the other end

of the barrel, and a guard fitted to said last-named end and extending lengthwise therefrom, and having an axially disposed light opening in the end.

INDUSTRIAL

A NEW LOCKING FEATURE FOR THE IMPROVED BUFFALO GRIP.

The Western Electric Company has recently placed on the market a new "Improved Buffalo Grip" with a special locking feature. In Fig. 1 the new grip is shown with the jaw held open by the locking device. A turn of the handle

Buffalo Grip with Jaw Closed

Buffalo Grip with jaw Held Open by New Locking Device

locks the jaw in any position and enables the lineman to easily and quickly insert the wire in the grip. When the handle is pushed down as shown in Fig. 2 the wire is held in a tight grip.

The "Improved Buffalo Grip" is made in various sizes for both bare and insulated wire, and can be supplied both with and without pulleys.

NEW INDICATING BOILER FLOW METER.

The betterment of station economy demands not only the employment of well-trained firemen and properly designed fire tools, but also the use of such instruments as recording pressure gauges, feed water thermometers and steam flow meters, to furnish the information by means of which high efficiencies and economical results can alone be obtained.

The new FS-2 boiler meter developed by the General Electric Company is designed to indicate the total amount of steam generated at any instant by a boiler or a battery of boilers in pounds of steam per hour, or in boiler horsepower. Therefore, it can be advantageously used for obtaining data for equalizing the load on individual boilers or a battery of boilers; for determining the efficiency in the method of stoking, or the correct feed water circulation; for determining the deterioration in efficiency due to the formation of scale; for discovering internal leaks as shown by the difference in water input and steam output; and for indicating the amount of steam distributed to different departments of a manufacturing plant, or the amount used in various manufacturing processes. In other words, it constitutes a valuable aid to engineers and firemen in maintaining an intelligent oversight of the fireroom.

The meter apparatus complete consists of a nozzle plug, the meter proper and the necessary pipes for connecting the nozzle plug to the meter.

The nozzle plug is similar to those used with the general line of steam, air, and water flow meters manufactured by the General Electric Company. It consists of a screw plug, provided with a stem having two sets of orifices—a leading set arranged longitudinally and a trailing set comprising three holes, located at the middle of the stem and at right angles to the leading set. The interior of the stem is divided longitudinally into two separate compartments, the leading set of orifices opening into one, and the trailing set opening into the other.

For operation, the nozzle plug is screwed into a small hole drilled and tapped in the steam pipe, with the stem extending across the pipe and the leading set of orifices facing the direction of steam flow. When thus arranged, the velocity of the steam causes a certain difference of pressure to exist in the two sets of orifices, and this difference of pressure is communicated through suitable pipes connecting the compartments in the nozzle plug stem with the U tube of the meter.

The body of the meter consists of an iron casting cored out to form one leg and the well of the U tube, the other leg being formed by one of the nozzle-plug connecting pipes entering the well at the opposite end. The well is filled with mercury, and the rest of the apparatus including the connecting pipes and the compartments in the nozzle plug is filled with water.

The movable mechanism of the meter comprises a small float resting on top of the mercury in one of the legs of the U tube and attached to a waterproof silken cord passing over a pulley and held taut by means of a counter balance weight acting on the pulley in the opposite direction, and a pair of horseshoe magnets—one inside the meter, attached to the pulley shaft, the other outside the meter, fixed to the pivoted end of the indicating needle. The axes of rotation of the two magnets are in line, and their mutual attraction exerted through a copper plug screwed into the side of the meter body casting, compels them to move in unison.

When the difference of pressure caused in the nozzle plug by the velocity of the steam flowing in the steam pipe is communicated to the two legs of the U tube, the mercury in the well rises or falls in the leg containing the float to a height proportional to the difference of pressure. The resulting motion of the float rotates the pulley, and the motion of the latter is transmitted through the pair of magnets to the indicating needle. The employment of the pair of magnets obviates the use of the troublesome packed joint which would be necessary for transmitting the motion of the pulley inside the meter to the indicating needle on the outside, by means of any form of mechanical connection.

The meter is easily installed, without interfering in any way with existing steam pipe arrangements. The work of installing merely requires the drilling and tapping of a small hole in the steam pipe for the insertion of the nozzle plug. The design of the latter permits of its insertion in pipes running either vertically or horizontally. Care should be taken, however, to select a straight run of pipe of at least 12 pipe diameters in length. The meter itself can be located in any desired place so long as it is kept below the nozzle plug. Its distance from the nozzle plug is immaterial, and it should be connected to the same with ¼-inch iron pipe of the required length. The best location is on the front of the boiler near the steam gauge, in plain view of the fireman and the engineer.

The dial scale is 8 inches in diameter, marked with heavy flow lines and large figures on a white surface, for easy reading. A target of conspicuous size is provided for designating a certain flow on the scale. This target can be readily set from the outside.

The meter can be calibrated to read in pounds per hour or in boiler horsepower (30 pounds of steam per hour being taken as equivalent to one boiler horsepower), for pressures ranging from 0 to 250 pounds, gauge; for quality ranging from 4 per cent moisture to 260 degrees F. superheat; and for pipe diameters of 2, 3, 4, 6, 8, 10, 12 and 14 inches. Meters calibrated for pipes larger than 14 inches in diameter can be furnished on special order. It will be noted in this connection that for any given case a meter of this type is calibrated for a certain pressure, quality and pipe diameter, and cannot be used for any other condition.

NEW CATALOGUES.

Bulletin No. 1152 from the Pittsburg Transformer Company lists two sizes of bell ringers, both transformers having three low voltages.

The Crocker-Wheeler Co. of Ampere, N. J., have issued a booklet on the efficiency of the Remek transformer, whose construction is illustrated in detail.

Bulletin No. 4850, recently issued by the General Electric Company, describes the new drawn wire tungsten filaments with which Mazda lamps are now equipped.

Hoskins electric furnaces and pyrometers are illustrated and described in a catalogue being distributed by the Machinery & Supply Co., Seventh and Harrison streets, San Francisco.

The Duncan Electric Manufacturing Co. of Lafayette, Ind., have just issued a new bulletin on the Duncan Model E Watthour Meter. The text describes a number of the good points of this meter in a most interesting manner.

The Machinery & Supply Co., Seventh and Harrison streets, San Francisco, are distributing catalogues descriptive of the Dietz Aerolectric Rock Drill, manufactured by the Economic Machinery Company of Denver, Colo.

Bulletin No. 1076 from Allis-Chalmers Co., on Power Transformers describes the theory underlying the construction of power transformers and shows illustrations of the various details of manufacture. Tables of efficiency and heating are also included.

Bulletin No. 4833, recently issued by the General Electric Company, describes a number of installations of electrically operated gold dredges, and contains information which should be of great interest to all connected in any way with this industry.

Bulletin No. 1081 from the Allis-Chalmers Company covers their polyphase induction motors. This bulletin contains a complete description of both Types "AN" and "ANY," together with photographs showing the details and applications of these motors. A list of ratings is also included.

In Bulletin No. 4835 the General Electric Company illustrates and describes various types of motor driven pumps designed for different purposes. Among the pumps illustrated are those for mine uses, pumps for operation in sewage disposal plants and dry docks, for irrigating purposes, and for use in connection with the water supply of houses.

Bulletin Nos. 4826 and 4827, just issued by the General Electric Company, describe that Company's water and air flow meters, respectively. The General Electric water flow meter provides a means of obtaining accurate information which will show the amount of water pumped, consumed, or distributed. The General Electric air flow meter provides a means for obtaining accurate information showing the exact amount of air compressed or distributed. Each bulletin contains a more or less detailed description of the meter to which it refers, and should be of interest to all users of air and water as working agents.

Two bulletins have recently been issued by the Engineering Department of the National Electric Lamp Association, the one entitled "Economical Operation of Incandescent Lamps" and the other "Mazda Incandescent Street Lighting." The first of these gives a detailed technical discussion of the principles involved and the methods to be used in determining conditions of most economical operation for incandescent lamps, from the standpoint of both consumer and central station. The text is elucidated by numerous curves and tables. The bulletin on street lighting is a revision of a former bulletin on this subject and gives distribution curves for some of the latest types of reflectors.

TRADE NOTES.

D. C. and Wm. B. Jackson, engineers at Chicago and Boston have moved their Chicago office from the Commercial National Bank Building to the 20th floor of the new Harris Trust Building, 111 West Monroe street.

J. P. Hermans has returned to San Francisco from a successful trip through the San Joaquin Valley in the interests of Colonial and Economy lamps handled by the Colonial Electrical Agency, San Francisco.

The Western Electric Company has recently received an order from the Oregon-Washington Railroad and Navigation Company for telephone train dispatching equipment for a circuit from Portland, Oregon, to The Dalles, Oregon, a distance of ninety miles. This circuit will be equipped with seventeen stations.

The Farnsworth Electric Works reports that their shop is exceptionally busy on repairs and redesigning of large apparatus. They report the sale of a 150 h.p. 2200-volt, three-phase induction motor to the Pacific Fruit Cooling and Vaporizing Company for use in their plant at Lodi, Cal., and a sale to the Grant Gravel Company of three 50 kw., 11000-volt primary 2200-volt secondary station type transformers. Another recent sale is that of a 100 kw., 250-volt railway type d.c. generator to the E. B. & A. L. Stone Company for use at their rock quarry railway at Thomasson, Cal.

Appreciating the growing importance of steel construction in tower transmission lines, the American Bridge Company of New York have decided to specialize on this class of work. While this company have in the past built structures for this purpose, they realize that permanent lines involving steel towers are becoming necessary, and that the larger public service companies must eventually rebuild existing lines with more stable equipment. Announcement has been made concerning the handling of work in this field. The firm of Pierson, Roeding & Co., of San Francisco, have been appointed the special representatives of the American Bridge Company for the Pacific Coast for the sale of poles and towers for electrical transmission. The activity of this well known firm in transmission work will be sufficient to guarantee that the American Bridge Company will furnish a fair share of this class of work.

CONTRACTORS' NOTES.

There will be quite a large electric wiring job on the new Native Sons' Hall which is under construction at San Francisco. Rhegetti & Hedman are the architects.

A seven-story hotel is being erected on the north side of Bush street, between Powell and Mason, San Francisco. The electric work will amount to about $5000, according to estimates. J. C. Newsom is the architect.

Specifications are out for the electric wiring for a large modern hotel which is being erected on the north side of Market street, between California and Sacramento, for the Pringle estate. Wm. Curlett & Son of San Francisco are the architects.

The Downtown Realty Company is erecting a theater and hotel building to cost about $300,000 on the southwest corner of Eddy and Mason street, San Francisco. If the electric work is as elaborate as is expected it will run from $20,000 to $25,000.

Plans are being figured for the electric work on the new Pantages Theater on Market street, opposite Mason, San Francisco. The electric work is estimated at approximately $1500, including a stage switchboard, etc. Miller & Colmesnil are the architects.

NEWS NOTES

FINANCIAL.

JACKSON, CAL.—That the Western States Gas & Electric Company intends to improve and develop its holdings in Amador county is evidenced by the filing of a mortgage covering its entire holdings. The mortgage is given to the Girard Trust Company of Philadelphia, and is for $10,000,000 at 5 per cent, the life of the mortgage being forty years, from June 1 of the present year. The mortgage is secured by the holdings of the company, including the Richmond Light & Power Company of Contra Costa County, the Stockton Gas & Electric Corporation of Stockton, the Humboldt, San Joaquin, Calaveras, Sacramento River Electric Company and land and water rights in Humboldt, San Joaquin, Calaveras, Sacramento and El Dorado counties. The purpose of the mortgage is to raise a fund to buy, develop and equip additional properties.

PUEBLO, COLO.—H. M. Byllesby & Company confirms the report of purchase of the Pueblo & Suburban Traction & Lighting Company and allied interests in Colorado, the property being taken over June 14th. The Pueblo & Suburban Traction & Lighting Company operates the street railway system of Pueblo and supplies electricity to Pueblo and the Cripple Creek gold mining district, including the cities of Cripple Creek, Victor and Goldfield. The towns of La Junta and Rocky Ford are served with electricity by subsidiary corporations. A steam electric power station of 4,135 kw. at Pueblo and a hydraulic power plant of 1600 kw. at Skagway are operated. Arrangements are being made to increase the capacity of the steam station at Pueblo and to extend transmission lines to serve additional cities and towns. Additional hydroelectric developments also are contemplated. W. F. Raber is at present in charge of management for Byllesby & Co.

INCORPORATIONS.

HERMISTON, ORE.—Hermiston Light & Power Company has been incorporated with a capital stock of $10,000.

PORTLAND, ORE.—Articles of incorporation have been filed by the Clatskanie Electric Light & Power Company, which is capitalized at $50,000.

SALEM, ORE.—Articles of incorporation have been filed by the Bully Irrigation & Power Company. Their principal office will be at Vale, Ore.; capital stock $25,000.

ILLUMINATION.

ROSEBURG, ORE.—Oakland, Oregon, has voted in favor of the issuing of $10,000 for a municipal lighting system.

HALSEY, ORE.—The Oregon Power Company has been granted a franchise for the construction of a lighting system here.

KLAMATH FALLS, ORE.—The county has refused to grant a gas franchise and it is suggested to erect a municipal plant.

LOS ANGELES, CAL.—The town of El Modena, in the foothills, is planning to have electric light and power, also to have gas piped into the town.

EL PASO, TEX.—B. P. Dubinski of El Paso has been given the contract for inside wiring for electric lighting at Fort Bliss. The Westinghouse Electric Company secured the contract for meters and transformers, and F. W. Newberry Electric Company of St. Louis has the contract for outside wiring. The entire cost will be $23,000.

LOS ANGELES, CAL.—The Southern California Edison Company has awarded to J. C. Farrar & Co. the contract to install certain electrical apparatus, including switches, switchboards, etc., at the Long Beach steam plant, Long Beach, Cal.

TRANSMISSION.

RIVERSIDE, CAL.—The Board of Supervisors has granted to the Pacific Light & Power Corporation a franchise for fifty years to operate and maintain an electric pole and wire system on all public roads of the county.

LEAVENWORTH, WASH.—The Tumwater Light & Power Company of this place has secured a franchise to construct and operate a light and telephone system from this place to Peshastin, then to the Chumstick river.

HOOD RIVER, ORE.—The Pacific Light & Power Company, which owns the Hood River water and light plant, proposes to increase its horsepower here and furnish power and light for farms between Hood River and The Dalles.

SEATTLE, WASH.—The Washington-Oregon Railroad Company will start at once on the construction of a large power plant on the Skookumchuck River to furnish electricity to the Hercules & Sandstone Company of Tenino, Wash.

LAKEPORT, CAL.—The Board of Supervisors has passed an ordinance granting to the Mt. Konocti Light & Power Company a franchise to put up an electric line to transmit light, heat and power along the public highways in the county of Lake.

EUREKA, CAL.—Since the Western States Gas & Electric Company has taken over the holdings of the Fortuna and Ferndale lighting companies, improvements are to be made throughout the valley. The substation at Loleta will be moved further up the river.

WALLA WALLA, WASH.—A franchise for 50 years has been granted the Pacific Power & Light Company, for a transmission line from Walla Walla City over the county roads to the Columbia county line, through Dixie and Waitsburg to Prescott. Construction is to begin at once.

BOISE, IDAHO.—The electrical power transmission line of the Beaver River Power Company will be extended from the Malad River plant northward into Boise and through the Payette country about October next, is the statement made by L. B. Fuller, manager of the company, with headquarters at Bliss.

RENO, NEV.—That there will soon be another power and light company doing business in this city and in other portions of Nevada in competition with the Hammon interests is now almost assured. The Nevada Power & Transportation Company will within a few weeks begin the construction of an 18-foot dam in the Truckee River near Vista, which will be used to back water up for the new power plant to be built there, and at the present time the company is building a power plant near Bishop, which will develop 35,000 h.p. when completed. This new company is backed by California capitalists, and it has named W. E. Caffrey, former city electrician of Reno, as its chief electrician. At the present time the Hammon interests controlling the Truckee River General Electric Company, has the monopoly of business of Western Nevada in power and lighting, and it is the intention of this new company to bid for a portion and to build a series of power plants in furtherance of the effort to obtain and retain it.

TRANSPORTATION.

VANCOUVER, WASH.—The Washington-Oregon corporation announced that they will extend the Main street car line.

BERKELEY, CAL.—E. C. Prather, engineer, Oakland, Cal., has been retained by the Oakland Traction Company, and other interested parties to make a new survey for a scenic line from North Berkeley to Grizzly Peak.

NAMPA, IDAHO.—Citizens of this place and Caldwell, Idaho, are on record as favoring the construction of the electric railroad between this place and Caldwell projected by W. E. Pierce of Boise. The right of way has been practically secured, and work will soon be started.

NEW WESTMINSTER, B. C.—The British Columbia Electric Railway Company will start work on the construction of an electric line to the Fraser river mills as soon as plans are approved by the City Council. The same company will soon start work on another line in this city.

BURLINGAME, CAL.—Ansel M. Easton has made application to the Board of Trustees for a franchise for a street railroad, and it is the intention of the board to grant this to the highest bidder. Sealed bids will be received by the clerk up to July 24th for the sale of the franchise.

OAKLAND, CAL.—The Southern Pacific Company has filed with the City Council formal application for permission to electrize its lines east of Fallon street to the boundary line of Oakland under its plan to change all its steam lines to an electric system, at a cost in the neighborhood of $10,000,000.

LODI, CAL.—The Board of Trustees has passed an ordinance granting to the Central California Traction Company a franchise of 47 years, to put in a single track, standard gauge line for the transportation of both freight and passengers, to be run by electricity, along certain highways in the county of San Joaquin.

WENATCHEE, WASH.—The City Council has granted a franchise to the Wenatchee Traction Company for the construction of an electric railway over the city streets. The company deposited a sum of $5000 guaranteeing that the first unit covering Wenatchee avenue will be completed in 18 months, and the second unit within two years.

WOODLAND, CAL.—The Vallejo & Northern Railroad has presented an application to the City Trustees for a franchise for its line over the main street of this city. The company is to begin construction work in a very short time on its air line between here and Sacramento, as its bridges across the Sacramento River will be completed by autumn. The Vallejo & Northern will connect with the Northern Electric at Sacramento and run to Vallejo via Winters, Vacaville and Suisun. A steamer line will connect it with San Francisco.

SACRAMENTO, CAL.—With the completion of the Northern Electric Company's new bridge now being built across the Sacramento River at the foot of M street, will come the extension of the company's lines to Woodland. The company has for a year been planning for this extension and another branch to run from Marysville to Colusa. Probably the Colusa branch will be started first, but it is assured, practically, that the Woodland extension will be commenced during the present year and probably be completed by the middle of next March. The company will not, for a year, build the line from Chico to Red Bluff.

LOS ANGELES, CAL.—The Southern Pacific and Salt Lake lines are to be merged with the Pacific Electric in Long Beach, according to authentic reports. The southern division of the trolley system is to dominate the united roads, and material for electrifying the steam lines is understood to have been already ordered. The merger will give the three roads absolute control of the inner harbor traffic, as the Pacific Electric owns a belt line around that harbor that joins with the city's railway leading to and on the municipal docks. Expenses will be lessened. This may lead to the landing of Southern Pacific steamships at Long Beach instead of San Pedro, as passengers landed at Long Beach can be transported here quicker than they can be carried from San Pedro. It is stated that 30 minutes can be saved in this way. The Pacific Electric will obtain control of 2.90 miles of the Southern Pacific and 5.60 miles of the Salt Lake road, a number of side tracks and spurs, and also several freight yards. The Pacific Electric bought a depot site to the right of the pier entrance. The Iaqua, a schooner carrying 230,000 feet of redwood lumber, docked at the Long Beach city wharf last Friday, being the first vessel to do so.

TELEPHONE AND TELEGRAPH.

NAPA, CAL.—W. M. Lyons has made application for a franchise for a period of 50 years for a telephone line along the public roads in the county of Napa. Sealed bids will be received for the sale of said franchise at the office of the clerk of the Board of Supervisors up to July 11, 1911.

UKIAH, CAL.—Hugh Coy has petitioned the Board of Supervisors for permission to erect poles and string wires and maintain same for telephone purposes. The line is to extend from the southwest corner of the race track one mile south of Ukiah, south along Ukiah and Hopland road. The petitioner was granted permission.

UKIAH, CAL.—The Willits and Laytonville Telephone & Telegraph Company has made application to the Board of Supervisors for permission to erect poles and string wires and maintain same for telephone purposes from the lower end of Long Valley to Willits, over the right of way of the new county road. The permission was granted.

WATERWORKS.

TACOMA, WASH.—The council has authorized the water superintendent to lay 400 feet of pipe on Cascade avenue.

OAKDALE, CAL.—Last Saturday Oakdale voted 217 to 42 for a waterworks, which means that fire protection will be extended to all, and by a vote of 213 to 28 a sewer system was made possible.

SEATTLE, WASH.—A special water bond election held in Snohomish resulted in favor of a $110,000 issue. Superintendent Miley of the Atlas Construction Company of Everett will at once start work.

REDMOND, ORE.—The Council has awarded to the firm of Jeffery & Bufton, contractors of Portland, a contract for the proposed waterworks system from Cline Falls to this city on their bid of $24,500.

SAN FRANCISCO, CAL.—The Spring Valley Water Company is to erect a pumping station at Lake Merced, on the corner of 23d avenue and Sloat boulevard. Plans have been prepared by Engineers L. Winther and H. Monett and are now being figured.

SALT LAKE CITY, UTAH.—Sealed bids will be received at the office of the Board of Public Works up to June 30th, 1911, for the work of constructing waterways at the intersection of Second South and Seventh East streets, according to plans and specifications on file in the City Engineer's office.

SAN FRANCISCO, CAL.—Treasurer McDougald has sold to the Western Metropolis National Bank $14,000 worth of the Sierra water supply bonds, the purchase being made by the bank for a client. The price paid was that under which all the treasurers' sales are made, par and accrued interest.